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# TREATMENT OF FRACTURE-DISLOCATION OF THE CERVICAL SPINE *

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Refinements of technique in the care of the broken neck have been developed recently, which are essential to the safety of the spinal cord and to the efficiency of the treatment. Among these are skeletal traction and tidal drainage. The author believes that open reduction and internal fixation should be added to these, and should be employed in a considerable percentage of fractures and dislocations of the cervical spine.

There is no single method applicable to every type, because the lesions vary widely in their requirements; but all must be treated with three cardinal points peculiar to the cervical spine in mind:

1. The cord must be protected at all times;
2. Reduction must be complete, or pain and recurrence may ensue;
3. The fixation must be adequate or recurrence will follow.

The criterion of any treatment is its performance in one or more of these respects. Skeletal traction, open reduction, and internal fixation are refinements which require trained surgeons and considerable skill. Properly used, they add immeasurably to the safety of the cord, to the quality of the reduction and fixation, and to the success of the end result.

## PREREDUCTION PHASE

Cord injury and increase or recurrence of deformity has taken place during first aid, during transport to the hospital, during the roentgenographic study, and during preliminary preparation. It has been the author's experience that all these dangers may be obviated by the use of an adjustable Thomas collar of the Forrester type sold by surgical-supply houses (Fig. 1). Such a collar possesses amazing efficiency, if clamped on tightly and kept tight during the few dangerous minutes.

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The first move is to apply one of these. Roentgenograms are then taken, and skeletal traction is applied if indicated. If the cord is damaged, tidal drainage is instituted without delay.

*Skeletal Traction*

When the cervical spine is under skeletal traction, correctly applied, the spinal cord is safe.* Until the advent of skeletal traction, the safety of the cord in dangerous cases was a constant source of anxiety; if spared by the initial injury, the cord was always in danger; if partly damaged, further loss might ensue.

FIG. 1
Adjustable Thomas collar

The relief from pain by this measure is always striking, and in those patients afflicted with root pain it is dramatic.

Where cord function has been interrupted, skeletal traction may be so applied as to permit frequent change of the patient's position in bed with safety, thus preventing decubitus. By its use the patient may lie on either side.

Skeletal traction frequently brings about reduction. It should not, however, be relied upon, solely, to effect complete reduction, as in this it is often not successful. Even when reduction is not accomplished by skeletal traction alone, its use is important to overcome spasm, to align the fragments, and to protect the cord and roots during open reduction. Exceptions to this procedure are the bursting fractures of the atlas (Jefferson's), and the extension fractures and dislocations where skeletal traction is the chief reliance.

The Crutchfield tongs, most easily applied of present-day devices, have slipped on two of the author's patients. In both the dome of the skull was uncommonly flat. In one case the tongs, with thirty-five pounds attached, pulled out during the third day; in the other, with fifteen pounds, the tongs shifted on the twelfth day, and had to be removed. Hoen wires, used in six cases, have proved reliable in the author's hands, provided the wire is correctly applied; but the technique of application

* Towne reports a patient with complete transection of the cord at the fourth cervical vertebra, who exhibited immediate embarrassment of pulse and respiration whenever gentle traction was applied to the head. This is the only exception which the author has found in the literature or in his own experience.

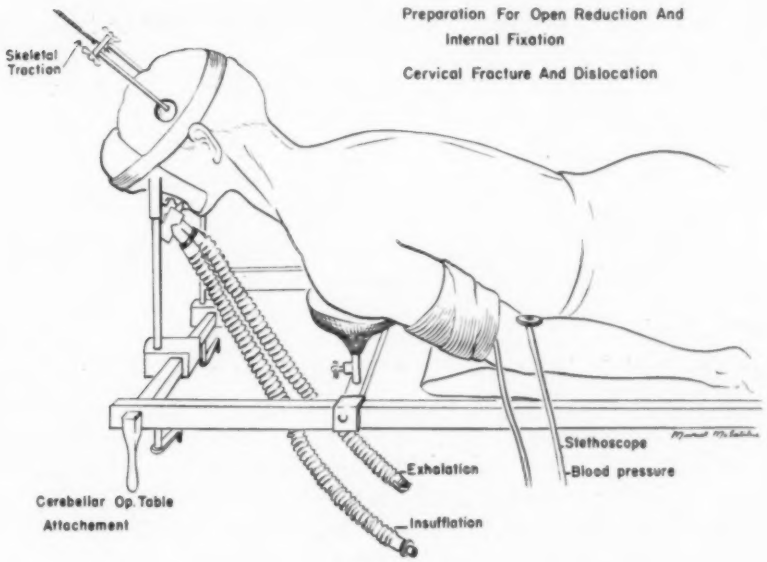


FIG. 2

seems unnecessarily complicated. Both of these methods permit the patient to lie on the side,—a real advantage.

## OPEN REDUCTION

If skeletal traction is not successful in effecting reduction, open reduction may be indicated. Closed manipulation has led to cord injury and death. Incomplete closed manipulative reductions may lead to recurrence of deformity, pain, and cord injury. Open reduction gives sight precision. In complex cases, such as those with fragmentation of the neural arch, safety to the cord, during reduction, may be expected only by this means. In dangerous or doubtful cases, the operation is performed with the cervical spine under skeletal traction.

### *Technique*

Intratracheal anaesthesia is decidedly preferable, as is the cerebellar head-rest attachment to the operating table. Skeletal traction is used in case of doubt (Fig. 2). Serious change of position of the involved vertebrae may occur without these precautions.

A mid-line incision is used, which extends upward from the prominent seventh cervical spinous process to the easily palpated second (Fig. 3*a*), or to the external occipital protuberance if the lesion is high. Through this incision the spinous processes are identified, and those of the involved vertebrae, together with one above and one below, are selected for subperiosteal exposure. The remainder of the exposure is subperiosteal (Fig. 3*b*). This may be made very easily, by the use of a very sharp, curved, and round-ended periosteum elevator, one-half inch in width. With it the bifid spinous processes are cleared without undue trauma; the

laminae are freed; and the exposure is carried laterally to include the posterior articulations.

Where the neural arch is fractured, the subperiosteal approach is made safe during stripping by steadying the spinous process with a toothed thumb forceps. This may require considerable care, and should never be undertaken without full realization of the danger.

The actual completion of the reduction has not been difficult in any case in this series (Cases 1, 2, and 8), the displaced bone being gently replaced with light, toothed, bone-grasping forceps.

*Internal Fixation*

In flexion injuries, once reduction has been effected, by whatever method, internal fixation is applied. Prolonged external fixation in cumbersome and often inefficient plaster jackets is frequently a sore trial to the patient, who is sustained in enduring them only by the fear of paralysis or death; and with it recurrences have been frequent.

Internal fixation prevents recurrence, and greatly simplifies convalescence. The appropriate vertebrae are wired together and bone grafts

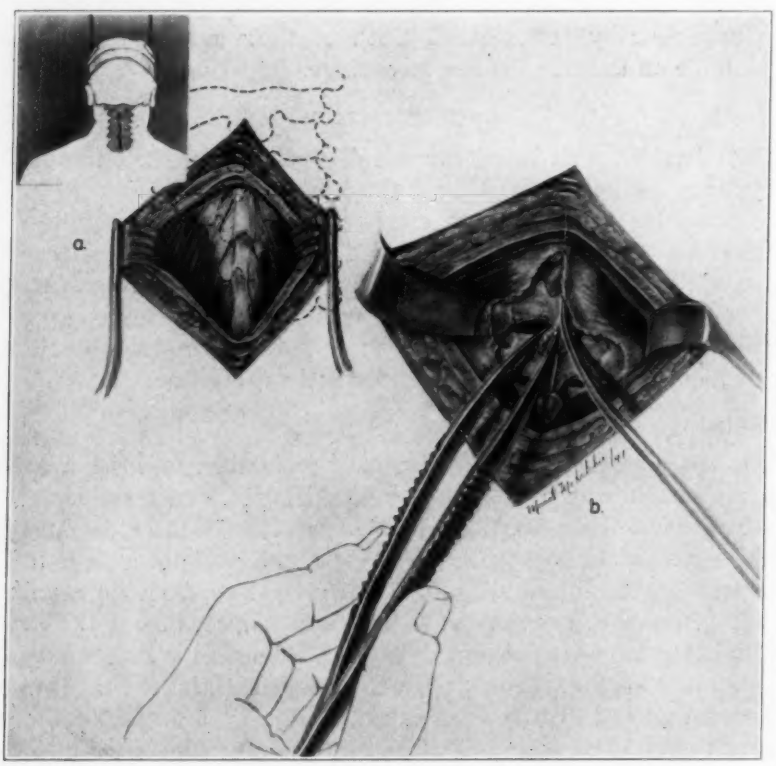


FIG. 3

Open reduction of fracture-dislocation of the cervical spine.
*a:* Surface anatomy, incision, and identification of spinous processes.
*b:* Subperiosteal exposure of posterior bone structures.

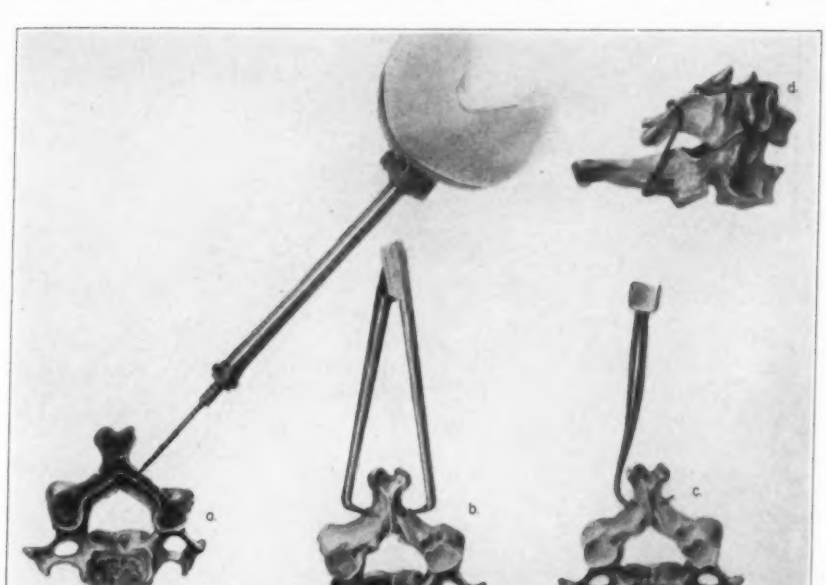


FIG. 4

*a:* A small drill hole is made in the outer cortex of the base of the spinous process on each side.
*b:* Volsellum forceps are used to complete the transverse hole.
*c:* The hole is enlarged with a small hook.
*d:* The vertebrae are fixed together with stainless-steel wire.

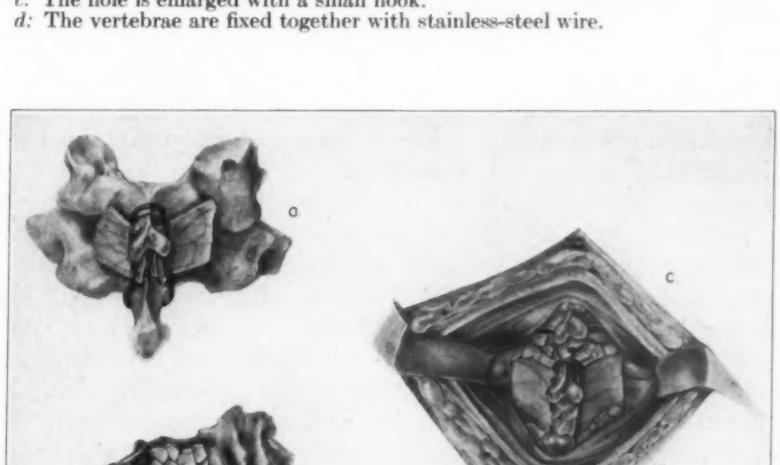


FIG. 5

*a:* Shows the manner of applying and fixing the bone grafts for fusion.
*b* and *c:* Bone chips are packed about the osteoperiosteal grafts.

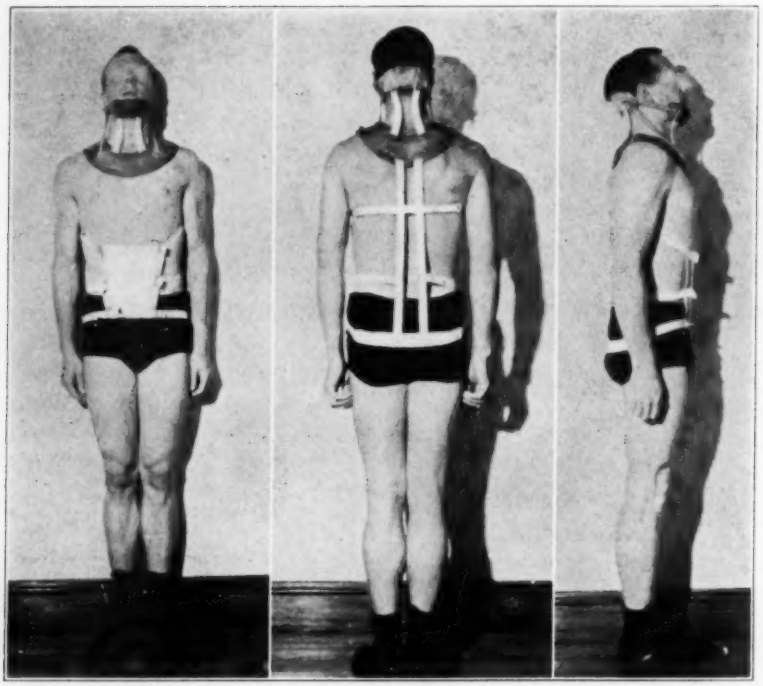

FIG. 6-A FIG. 6-B FIG. 6-C

The brace is worn until fusion is complete, to supplement the internal fixation and to prevent the wire from eroding the bone. Without internal fixation the brace cannot be relied upon to prevent recurrence.

are placed so as to bridge the interspinal and interlaminar spaces at the completion of the open reduction. Applied in the manner to be described, and with strict attention to the conditions of convalescence, the wire fixation has held in every instance—eleven cases—and maintained position long enough for fusion to take place.

Babcock stainless-steel wire, No. 24, is satisfactory, and does not cause osteolysis. In each of the spinous processes to be fixed, a small transverse hole is made at the point of junction of the process with the laminae. This may be accomplished with a volsellum forceps or a large beetle-jawed towel clip, since the medulla is not heavily trabeculated (Fig. 4*b*). The hole is completed with a small hook (Fig. 4*c*). It is helpful to start the hole with a small drill on the oblique (Fig. 4*a*). The wire is looped around the superior border of the upper process, and the ends are passed through the hole in that process in opposite directions. The ends are passed distally and parallel across the interspinal space, and then in opposite directions through the hole in the process below. This is repeated until the lowest process to be fixed has been included. One end is then looped around the inferior border of this process; the wire is made snug; and the ends are fastened by twisting (Fig. 4*d*).

A pair of osteoperiosteal grafts, one on each side, are laid transversely, bridging each interspace. The adjoining portions of the pair

FIG. 7-A

FIG. 7-B

Case 1. On admission. Complete anterior dislocation of the sixth cervical vertebra on the seventh, with temporary quadriplegia.

Fig. 7-A: Crutchfield-tongs traction was employed without obtaining reduction. Complete reduction was obtained by open operation. Skeletal traction was used during the operation.

Fig. 7-B: Roentgenogram taken with patient in hyperflexion shows complete reduction and bony union which was present in four months. Patient returned to work in five months. There was no loss of cord function during treatment and there has been no recurrence of the dislocation.

of grafts are forced between the parallel portions of the wire fixation. In this way, they are held in place (Fig. 5*a*). Bone chips are packed in wherever possible (Figs. 5*b* and 5*c*). There has been no failure of fusion by rigid test in the eleven cases so treated.

Two, and at times three, vertebrae are included in the internal fixation and fusion. In cases of dislocation, the dislocated vertebra is fixed to the one below; in cases of fracture, the fractured vertebra is fixed to the one above,—provided there is bone continuity between the body and spinous process of each. If bone continuity is lacking in either, the next intact arch on the same end is substituted. The problem of selection of the vertebrae to be fused must be carefully studied in the roentgenograms before operation, since spontaneously reduced dislocations or even fractures may be missed. These are suggested in cervical spines, free of degenerative changes, by unexplained narrowing of the intervertebral spaces. Only once has the author found it necessary to fix more than three vertebrae. It is essential to identify, by a portable x-ray unit, during operation, the vertebrae to be fused, if reduction had been effected preoperatively; otherwise the wrong vertebrae may be fused.

FIG. 8-A

FIG. 8-B

Fig. 8-A: Case 6. On admission. Complete anterior dislocation of the fifth cervical vertebra on the sixth with no cord injury. Reduction was obtained by Hoen-wire traction-extension.

Fig. 8-B: Wire fixation of the fifth and sixth cervical vertebrae and fusion operation were performed. Bony union was complete in five months, and the patient returned to work in six months.

FIG. 9-A

FIG. 9-B

Fig. 9-A: Case 3. On admission. Compression fracture of the body of the fifth cervical vertebra and fracture of the lamina, with temporary quadriplegia. Almost complete reduction was obtained by head-halter traction-extension.

Fig. 9-B: Wire fixation of the fourth, fifth, and sixth cervical vertebrae, and fusion operation were performed. Fusion was complete in three months, and the patient returned to work as a linotyper in two and one-half months.

### POSTOPERATIVE COURSE

Patients, with whom there has been no interruption of cord function, have remained recumbent for three to five weeks. If skeletal traction was employed before operation, it is reduced to about five pounds, and is continued during the period of recumbency,—the patient lying upon a flat bed. If skeletal traction was not employed, anterior and posterior plaster shells are used alternately after operation for the same period.

Patients with interruption of cord function should remain recumbent until the neurological condition permits them to be ambulatory.

When patients become ambulatory, the internal fixation is aided by a light and comfortable external support (Figs. 6-A, 6-B, and 6-C). The brace prevents motion of the neck beyond a limited degree. This protects the neural arches of the wired vertebrae from greater tension than they can stand. In all of the cases this protection was employed, and in none was there any pulling through the bone by the wire. The brace is worn until bone fusion is complete.

### END RESULTS

Open reduction, internal fixation, and fusion have been employed in a series of eleven cases.

In every case, the internal fixation maintained reduction until fusion was complete, with one exception (Case 4). In this case the dislocated

FIG. 10-A

FIG. 10-B

Fig. 10-A: Case 10. On admission. Anterior fracture-dislocation of the second cervical vertebra on the third; compression fracture of the body of the third; no cord symptoms. Almost complete reduction was obtained by head-halter traction-extension.

Fig. 10-B: After wire fixation and fusion operation of the first, second, and third cervical vertebrae were performed, fusion was complete in three months, and the patient returned to work in four months.

TABLE I

RÉSUMÉ OF ELEVEN CASES OF FRACTURES AND DISLOCATIONS OF THE CERVICAL SPINE

| Case | Type | Cord Injury | Traction | Reduction | Internal Fixation | Fusion Obtained | Approximate Time for Fusion (*Months*) | Recurrence | Return to Work (*Months*) | Loss of Cord Function During Treatment |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Complete anterior dislocation of 6th cervical on 7th | Temporary quadriplegia | Crutchfield tongs | Open, complete | Fusion operation with braided-silk suture of 6th and 7th cervical | Yes | 4 | No | 5 | No |
| 2 | Compression fracture of body of 5th cervical, with fracture of posterior wall of body | None | Crutchfield tongs | Almost complete by traction; completed at operation | Fusion operation with wire suture of 4th, 5th, and 6th cervical | Yes | 3 | No | 4 | No |
| 3 | Compression fracture of body of 5th cervical; complete fracture of lamina | Temporary quadriplegia | Traction-extension by head halter | Almost complete by traction | Fusion operation with wire suture of 4th, 5th, and 6th cervical | Yes | 3 | No | 2½ | No |
| 4 | Partial anterior dislocation of 5th cervical on 6th | None | Crutchfield tongs (slipped) Hoen wire | Complete by traction | Fusion operation with wire suture of the 6th and 7th cervical | Yes | 3 | Partial | 4 | No |
| 5 | Partial anterior dislocation of 5th cervical on 6th; fracture of spinous process of 5th | Right hemiparesis | Traction-extension by head halter | Complete by traction | Fusion operation with wire suture of 4th, 5th, and 6th cervical | Yes | 7 | No | 8 | No |

TABLE I (*Continued*)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | Old complete anterior dislocation of 5th cervical on 6th | None | Traction-extension by Hoen wire | Complete by traction | Fusion operation with wire suture of 5th and 6th cervical | Yes | 5 | No | 6 | No |
| 7 | Old unilateral dislocation of 1st cervical on 2nd | None | Traction by head halter | Open, complete | Fusion operation with wire suture of 1st and 2nd cervical | Yes | 5 | No | 5 | No |
| 8 | Old, complete, anterior dislocation of 1st on 2nd cervical, with fracture of odontoid | Paresis, paraesthesia, hypaesthesia of 4 extremities | None | Correction to neutral | Craniotomy and laminectomy of 1st cervical; fusion of occiput, 2nd, and 3rd cervical | Yes | 6 | No | Has not returned to work | Yes |
| 9 | Complete anterior dislocation of 5th cervical on 6th | None | Traction by Hoen wires | Complete by traction | Fusion operation with wire suture of 5th and 6th cervical | Yes | 4 | No | 4½ | No |
| 10 | Anterior fracture-dislocation of 2nd cervical on 3rd; compression fracture of 3rd cervical | None | Traction-extension by head halter | Almost complete by traction | Fusion operation with wire suture of 1st, 2nd, and 3rd cervical | Yes | 4 | No | 5 | No |
| 11 | Old partial anterior dislocation of 5th cervical on 6th | Right hemiparesis | Hoen wires (broke) Crutchfield tongs | Complete by traction | Fusion operation with wire suture of 5th and 6th cervical | Yes | 3½ | No | Ataxia unchanged in six months; has not returned to work | No |

FIG. 11-A

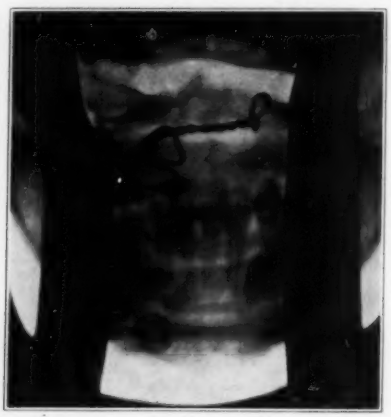

FIG. 11-B

Fig. 11-A: Case 7. On admission. Old unilateral dislocation of the first cervical vertebra on the second; no cord injury. Head-halter traction-extension failed to effect reduction.

Fig. 11-B: Same after open reduction, showing wire fixation and fusion of the first and second cervical vertebrae.

FIG. 11-C

FIG. 11-D

Case 7. Preoperative and postoperative lateral views. Fusion was complete and patient returned to school in five months.

vertebra had been reduced before operation by skeletal traction. At operation it was mistaken for the vertebra above, and the two vertebrae next below were wired together. This error was not detected until three months after operation when roentgenograms revealed a moderate recurrence. Fusion occurred in all eleven cases, judged by lateral roentgenograms taken in maximum flexion and extension. The average time of fusion in the eleven cases was four months.

FIG. 12-A

FIG. 12-B

Fig. 12-A: Case 8. On admission. Old anterior dislocation of the first cervical vertebra on the second, with paresis of the four extremities. Enlargement of the foramen magnum and laminectomy of the first cervical vertebra were performed, with fusion operation of the occiput and the second and third cervical vertebrae.
Fig. 12-B: Fusion was complete in six months; cord symptoms are improving.

There was no loss of cord function during treatment in ten of the eleven cases. Temporary aggravation of cord symptoms was noted in one case immediately following operation,—Case 8, an anterior dislocation of the atlas on the axis with fracture of the odontoid, of nineteen years' duration. Laminectomy and enlargement of the foramen magnum was done by John Hodgson, M.D., of the Neurosurgical Service at the time of fusion, to provide more space in the neural canal. Fusion of the occiput to the second and third cervical spinous processes was done. The patient soon regained lost ground, and is very much better than before the operation.

Nine of the eleven patients returned to their work in an average of five months. The range of motion in rotation varied from 45 to 140 degrees, depending upon the vertebrae fused. (See Table I.)

## HISTORICAL REVIEW

In America, Crutchfield and Hoen have pioneered in the field of skeletal traction; and Munro, in tidal drainage. Many others, including McKenzie and Barton, have contributed to our knowledge of skeletal traction. Ryerson and Christopher, reporting a case of internal fixation by wiring and fusion operation in 1937, found in the earlier literature a report of wire fixation by Hadra in 1891, and silk-ligature fixation by Lane in 1892. Known to all is Mixter and Osgood's silk-ligature fixation

in 1910. Later Cotton employed wire in a patient to prevent recurrence. Fusion was reported by De Quervain and Hoessley in 1917, Hibbs in 1922, Krida in 1930, Cone and Turner in 1937, Gallie in 1939, and others. Gallie and Badgley have each accumulated series of cases treated by wire fixation and fusion operation, and Funsten has studied metallic internal fixation in dogs. Open reduction has been performed in the past through the posterior approach by Ryerson and Christopher, Gallie, and others.

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# THE POSSIBILITIES OF THE ROENTGENOGRAPHIC STUDY OF THE ARTERIAL CIRCULATION IN THE EARLY DIAGNOSIS OF BONE MALIGNANCY

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The diagnosis of malignant bone tumors now depends on clinical, pathological, and roentgenographic data.

Arteriography as an additional aid in the diagnosis of malignant bone lesions was first presented by dos Santos, Lamas, and Caldas.[1] Experimental research and clinical application in a series of cases have convinced the author that, if a careful technique is followed, arteriography can be of definite assistance in the early diagnosis of malignant lesions of bone, provided that the lesion is localized so that the early circulatory changes are evident by x-ray. Since it is an accepted fact that the earlier the diagnosis of malignancy is made, the greater are the possibilities of effective treatment, any procedure which will assist in an earlier proof of malignant growth is worthy of consideration. An accurate diagnosis while the neoplasm is still limited to the bone and no invasion of the soft tissues is yet evident offers the advantage of a surgical block resection, as advocated by Albee, a type of operation often accepted by the patient without the hesitancy encountered when an amputation is suggested.

FIG. 1

Arteriogram of normal femoral artery and branches after injection of twenty cubic centimeters of thorotrast.

The ability to recognize the important changes demonstrated by this procedure depends largely on a comprehensive knowledge of the appearance of the normal arterial circulation. The arteriographic aspect of an osteogenic sarcoma of the lower third of the femur (Fig. 2-B) is in marked contrast to the appearance of a normal femur of an adult (Fig. 1) after the subcutaneous injection of twenty cubic centimeters of thorotrast into the femoral artery. In the arteriogram the stroma of the tumor, as well as the actual size and area of invasion, can be demonstrated in

FIG. 2-A

Roentgenogram of bone lesion of lower third of femur. Roentgenographic diagnosis: bone sarcoma.

FIG. 2-B

Arteriogram of same case as shown in Fig. 2-A. Here the stroma of the tumor and the atypical arterial network with numerous pedicles penetrating the tumor are easily seen, and the neoplastic invasion is clearly demonstrated.

addition to the important arterial changes, whereas a simple roentgenogram (Fig. 2-A) shows only slight signs of a bone tumor.

The question arises as to whether arteriography as a diagnostic procedure can be depended upon to differentiate malignant bone lesions from other pathological conditions of bone. Normal arterial circulation is easily demonstrated. In the study of bone pathology there are two very common variations in the arterial circulation,—ischaemia and hyperaemia.

Ischaemia is usually associated with some of the most common affections of bone,—such as syphilis and chronic osteomyelitis. It is characterized by a lack of normal blood supply in the affected bone, with very few blood vessels surrounding the lesion and those that are visible having the appearance of normal arteries.

Apparent ischaemia may be the result of deficient filling of the arterial branches due to improper technique,—either an insufficient quantity of the injected contrast substance, its slow injection, or the exaggerated speed and rapid evacuation of the contrast medium. Ischaemia may be produced by a mechanical block of the main artery or its branches by extrinsic or intrinsic causes,—as an arteriovenous aneurysm, angiospasms, endarteritis obliterans, or other pathological condition of the vessels. An example of obstruction by a benign fibrous mass is shown in Figure 3.

On the other hand, arteriography may show an increase in circulation due to a pathological bone condition, with numerous normal ramifications of the arteries surrounding the lesion and some enlargement of the arterial branches. This picture is characteristic of hyperaemia,—such as is evident in bone and joint tuberculosis and in other inflammatory conditions of bone.

Therefore, an increase in the normal circulation, hyperaemia, or a decrease of the blood supply, ischaemia, is a definite diagnostic sign in a number of bone lesions any one of which, clinically and roentgenographically, might be mistaken for a malignant bone tumor in the early stage. However, the peculiarities of the abnormal blood circulation observed in neoplasms are sufficiently well defined to differentiate between a benign bone lesion and a malignant bone tumor.

FIG. 3

Arteriogram of femoral obstruction above tumor, showing numerous collateral branches which maintain circulation and surround a large fibrous mass of callus in an old fracture of the femur. There is marked ischaemia in the region of the fracture.

To prove that arteriographic signs of malignancy are present in every case of bone neoplasm and that they are sufficiently prominent to lead to a positive diagnosis in any case of malignant bone lesion, a more extensive experience than that of the author's would be necessary; nevertheless he has found that in every one of his cases in which an arteriographic diagnosis of malignancy was made, the accuracy of that diagnosis has later been verified either by pathological examination or by the clinical course.

The most striking and characteristic arteriographic sign of bone malignancy is the filling in of the stroma of the new growth by numerous vessels, forming an erratic network and showing the extension of the invading tumor. Careful examination of the arteriogram under a magnifying glass enables one to trace these vessels and their irregular, disorderly distribution into the tumor mass. These typical changes are clearly shown in Figure 4.

Another evidence of malignancy is the presence of new atypical arterial circulation with pedicles from the main artery and numerous irregular branches entering the bone lesion. This is an important observation, since it defines clearly the limits of the lesion (Fig. 5). The

FIG. 4

Arteriogram of malignant bone tumor, showing the filling in of the stroma by newly formed vessels, constituting a network which divides and changes their course in a most atypical and erratic manner.

FIG. 5

Arteriogram showing numerous arterial pedicles penetrating the tumor in an atypical and irregular manner,—a most important sign of bone malignancy. Arteriographic diagnosis: osteogenic sarcoma.

FIG. 6

Venogram showing increased and atypical circulation. Diagnosis: bone sarcoma.

premature appearance of very rich venous circulation, with formation of gross venous pedicles arising from the tumor and entering the neighboring vein, is also an important sign. Figure 6 shows this rapid and atypical venous circulation. Another observation, which is evident only in the more advanced cases, is the increased arterial circulation which appears to be distributed perpendicularly to the bone,—actually the early form of the radiating bone spicules characteristic of certain types of osteogenic sarcoma.

FIG. 7

Ascending arteriogram. Uroselectan B (51-per-cent. solution) was injected into the femoral artery, and the vessels below the point of injection were temporarily closed by manual compression of the epigastric region. The deep femoral artery, the external and internal iliac arteries on both sides, and the vertebral arteries are clearly visible. The nutrient artery of the femur can be seen, and the contour of the kidney and the renal artery are also visible.

### TECHNIQUE

A group of four are required to carry out the technique in making an arteriogram as it is generally followed. One surgeon, with an assistant, is responsible for finding the artery and inserting the needle within it. The artery may be reached by subcutaneous approach or may be exposed. The femoral artery at Scarpa's triangle is usually selected for the lower limbs, although the popliteal or any other main artery may be chosen. For the upper extremities, the brachial artery or the axillary artery is often chosen, but the subclavian artery may be used.

The same surgeon is responsible for the injection of the contrast substance into the artery. He must block the arterial circulation, either by pressing with one finger just above the point of injection, or by using any other convenient method to obtain temporary occlusion of the vessel during the period of the injection. The substance is injected at the rate of two cubic centimeters per second.

While the injection is being given, the x-ray operator makes three

successive exposures, two of the arterial and one of the venous circulation, using the highest milliamperage possible with the greatest kilovoltage. The time of exposure must be less than one-tenth of a second. An assistant is needed to help in changing the films rapidly.

### OVERCOMING THE OBJECTIONS TO THE METHOD

Many criticisms have been published regarding this method of arteriography, but none of them, in the author's opinion, is sufficiently sound or convincing to condemn a procedure which makes possible a positive and early diagnosis of bone malignancy. Any efforts to minimize the possibilities of error and to make the method simpler, so that it may have a place in routine investigation, should be encouraged. Among the factors to be considered are:

1. The need of a sufficiently concentrated and opaque substance to allow the arterial circulation to be definitely shown in the arteriogram.

2. The importance that the substance employed be absolutely harmless and easily eliminated without any unpleasant aftereffects.

3. The necessity that the substance injected always reach the area of the suspected tumor, so that the changes in circulation may be clearly shown in the film.

4. The absolute necessity of obtaining roentgenograms so clear that the finest vessels and the intraosseous circulation may be readily observed.

5. The importance of avoiding any technical defects which might lead to misinterpretation of the arteriogram and subsequent incorrect diagnosis.

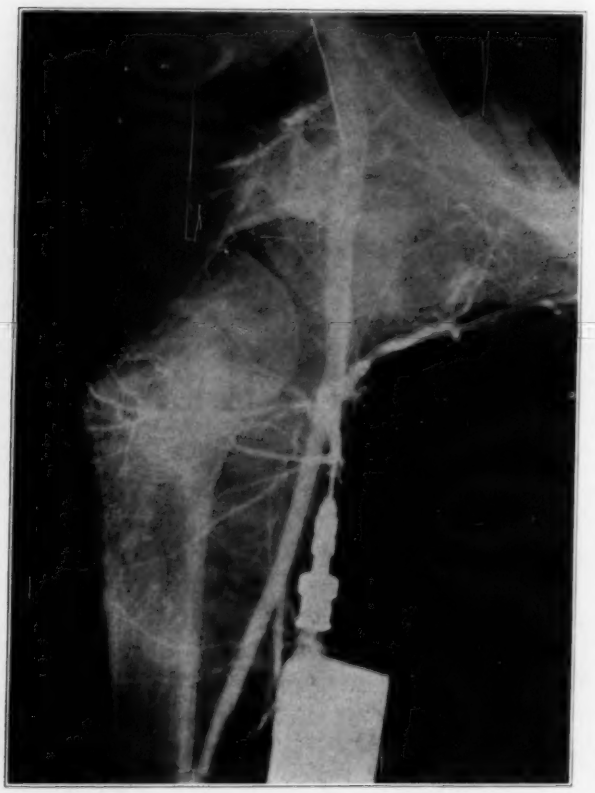

FIG. 8

Ascending arteriogram showing typical signs of malignancy and the invasion of the tumor beyond the humeral limits with the same circulatory changes. This invasion is shown by the upward filling of the axillary and subclavian arteries.

*The Choice of the Substance to be Injected*

In considering the first of these five points it should be remembered that, although the history of arteriography is quite recent, the use of opaque substances aiming toward improvement in the study of the arterial circulation is not new. Although familiar with the reports of the experimental work of dos Santos, Lamas, and Caldas on different opaque substances, the author decided to carry out independent studies, observing several solutions, checking their toxicity as well their opacity. The substances selected for study under identical conditions and used in the same technique were:

(a) Uroselectan B (commonly used for pyelography).
(b) Uroselectan B concentrated, 51-per-cent. solution (used for intravenous pyelography).
(c) Perabrodil (simple).
(d) Perabrodil concentrated, 50-per-cent. solution, a new formula.
(e) Thorotrast.
(f) Lipiodol.

Of these, thorotrast, or thorium dioxide, seems to be the best choice for arteriography. If this substance is used in doses of 10 to 20 cubic centimeters, the carcinogenic property of this radio-active substance seems to be nullified.

It should be recorded that perabrodil (50-per-cent. solution) has been used in five cases, without any great discomfort, and in our experimental work it has also appeared to be less painful than is uroselectan B concentrated.

Although lipiodol offers a wonderful contrast, the injection of this substance into the artery is most

FIG. 9

Showing method of ascending aortography in a dog after catheterization of the femoral artery, using a 70-per-cent. solution of diodrast. (*Courtesy of Dr. P. L. Fariñas and the American Journal of Roentgenology and Radium Therapy.*[2])

FIG. 10

Roentgenogram showing tumor mass on lower aspect of condyle. In this case pain and swelling were noted one month after trauma to the knee. Clinical diagnosis: probable malignant bone tumor. Roentgenographic diagnosis: osteogenic sclerosing bone sarcoma.

FIG. 11

Arteriogram showing positive signs of bone malignancy. A new arterial pedicle has been formed well above the zone of the tumor and extending to its anterior aspect.

difficult,—the filling of the vessel is not uniform, resulting in intermittent filling of the artery. Moreover, in some cases it is retained for a period of time, in one case for more than a week, and there is always the risk of embolism when this product is used.

*The Ascending Arteriogram*

A very important limitation to this method of arteriography is the one referred to in our third point. The suspected bone tumor is sometimes located in regions which the opaque substance cannot reach by the usual technique of injection,—for instance, about the hip, the shoulder, or the spinal column. It is recognized that arteriography may be used in any of the large vessels. Aortography has been employed by dos Santos, Lamas, and Caldas for abdominal diagnosis; the internal carotid may be injected for cerebral angiography; and hepatography is well known. However, the use of these procedures entails greater difficulties than those encountered when more accessible vessels are used.

In the author's effort to improve upon the technique employed in such cases, he has developed the ascending arteriography in which he has been able to inject against the arterial stream and obtain the filling of the

FIG. 12-A

Roentgenogram showing tumor mass on lower third of femur invading popliteal space. There was a history of pain and swelling of two months' duration. Roentgenographic diagnosis: osteogenic sarcoma.

FIG. 12-B

Same femur after a pathological fracture. Arteriogram showing evidence of bone malignancy.

arteries away from the point of injection. Figure 7 shows how well the ascending arteriogram visualizes the abdominal, spinal, and renal circulations in a dog. This arteriogram was taken while uroselectan B was being injected into the femoral artery, against the normal direction of the blood stream, pressure on the descending aorta meanwhile interrupting the arterial circulation.

In the case illustrated by Figure 8, an ascending arteriogram was made to demonstrate a malignant bone tumor of the upper end of the humerus. Ascending aortography has been performed by Fariñas by introducing a long, thin catheter into the femoral artery and carrying it upward to the descending aorta (Fig. 9).

If it is necessary to obtain an arteriogram which will show the smaller arterial branches of a certain area in greater detail, this may be done by limiting the filling of the arteries to that region and obstructing the passage of the opaque substance from it.

*The Bucky Diaphragm*

While the author is well satisfied with the technique which has been followed by the roentgenologist, he believes that the use of an extra fast

Bucky diaphragm would greatly improve the roentgenographic details of the arterial circulation.

*Errors to be Avoided*

Any defect in the technique may lead to complete failure to obtain the arteriogram or the complementary venogram. The errors most frequently made are as follows:

1. Mistakes may be made while trying to enter the artery,—such as placing the needle in the femoral vein. In this case the contrast substance will be carried into the venous circulation and the arteriogram will be a failure.

2. If the needle, when placed in the artery, is either withdrawn or pushed through both walls at the time of injection, the films will not define the vascular tree but will show the accumulation of the extravasated opaque substance around the site of injection.

3. The injection may be either too slow or too fast, owing to lack of or excess of pressure, or because a very narrow or a very wide needle is used. To overcome this difficulty, dos Santos has developed an injector of his own design. The width of the needle has also been standardized,—another improvement. The author has not used any particular type of injector, but has always selected a sterilized twenty-cubic-centimeter serum syringe with a large platinum needle. He has measured and repeatedly practised the speed for injection, counting in seconds to obtain the correct amount of pressure so that the twenty cubic centimeters of fluid contained in the syringe would be injected in ten seconds.

4. The lack of synchronization between the injection and the x-ray exposure is noticeable (an automatic switch for the x-ray exposure might help to correct this defect). Exact timing is most essential, because, if the exposure is done too rapidly, the arteriogram will not show sufficient filling of the arteries to justify a proper diagnosis. If it is performed too slowly, the venous circulation will appear at the same time as the arterial circulation, making the reading of the film most difficult.

5. If the compression is not maintained during the period of injection, the opaque substance will be carried out by the blood stream and little or none will be evident in the arteriogram. It is important that the exposure for the venous circulation be made immediately after the pressure is released; otherwise the venous circulation will not be registered.

6. Motion on the part of the patient will cause blurred roentgenograms, unsuitable for diagnosis. To avoid such accidents, general anaesthesia has been recommended when painful substances are to be injected. However, the author has used general anaesthesia only in small children, as experience has shown that the injection of thorotrast is practically painless and the normal adult easily tolerates the burning sensation produced by perabrodil, concentrated.

The illustrations show the characteristic aspects of the arterial circulation in different types of bone neoplasm.

## CONCLUSIONS

Arteriography is of importance and practical value in the differential diagnosis of borderline lesions of bone. It will reveal and clearly determine the malignant or benign character of the lesion, and it thus becomes of primary consideration in the early diagnosis of bone malignancy.

The advantages of arteriography as a method for the early diagnosis of bone malignancy are dependent primarily on how early in the disease this form of investigation is undertaken. Arteriography will afford a definite diagnosis of a bone neoplasm in an accessible region when the contrast obtained by the opaque substance used is clear and the technique employed is so exact that the slightest deviation from normal in the arterial circulation is detectable.

The author has found, from both clinical and experimental work, that the use of ascending arteriography broadens the field for the employment of this method of investigation, since it may be employed when the use of descending arteriography would be either impractical or impossible.

This procedure deserves further trial, especially in large institutions devoted to the study of cancer, where its real value may be ascertained. All contributions leading to a better understanding of this method and the minimizing of the errors in technique should be encouraged, so as to make possible a complete evaluation of its present and future possibilities as a diagnostic aid.

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# FRACTURES OF THE LATERAL CONDYLE OF THE LOWER END OF THE HUMERUS WITH COMPLICATIONS

## A Simple Technique for Closed Reduction of Capitellar Fracture

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Supracondylar fractures are common in South India and various types have been encountered which give rise to difficulty in reduction and in the restoration of function. The most difficult type is the fracture of the lateral condyle, which in children is called the capitellar fracture. This fracture is interesting because it is not common.

The cause of this fracture, and the pathological anatomy of displacement of the fragments, have not been clearly understood, and there are very few authenticated reports which show the difficulties in treating the complications, or the results of follow-up. In an analysis of thirteen cases of fracture of the lateral condyle, three were in adults and ten in children ranging from four to twelve years of age, with an average age of seven years. Seven fractures occurred on the left side, and six on the right.

Stimson has stated: "It is easy to produce a fracture by adduction of the extended forearm in bodies of the young or by a blow upon the palm with the elbow flexed at a right angle." This adduction causes strain upon the lateral ligament and the muscles that take origin from the epicondyle. This seems to be a reasonable explanation of the mechanism of the fracture.

### PATHOLOGICAL ANATOMY

Various types of displacement occur with this fracture. The simplest in this series was a lateral and upward tilt of the capitellar fragment, and the most severe, a complete displacement in which the capitellar fragment turned a somersault within the joint (Figs. 1-A, 2-A, 2-B, 3-A, and 4-A).

Wilson [6] has stated: "This displacement is due to the contraction of the long extensor muscles of the wrist and fingers, which take their origin, by means of a common tendon, from the lateral condyle of the humerus"; but the author, in experiments upon cadavera in which all the muscles of the elbow joint were removed, with the exception of the origin and insertion of the brachioradialis and extensores carpi radialis, found that when a fracture was produced beneath the origin of the extensor carpi radialis longus and extensor carpi radialis brevis, the condylar fragment was tilted outward and upward without any marked displacement, and that this occurred in supination only. On pronation the fragments came together easily.

When the fracture occurred with the avulsion of the fragment and both the extensors, the displacement was a little more exaggerated than before, but the fragment did not turn over until the anterior and posterior parts of the capsule were also torn with it, and the forearm was in marked adduction. In this condition the typical displacement seen in roentgenograms occurred. The displacement is of a rotational character in which the articular surface is directed medially and upward, and the fractured surface is pointed backward, laterally, and downward, so that the upper end of the capitellar fragment is directed downward and the lower end upward. The line of fracture is usually from above downward, and, directed medially toward the trochlear surface, extends from the lower end of the dipahysis of the humerus through the epiphyseal cartilage to the articular end. In some cases of adult fractures, the displacement of the fragment is more backward, simulating a dislocation of the elbow (Case 2).

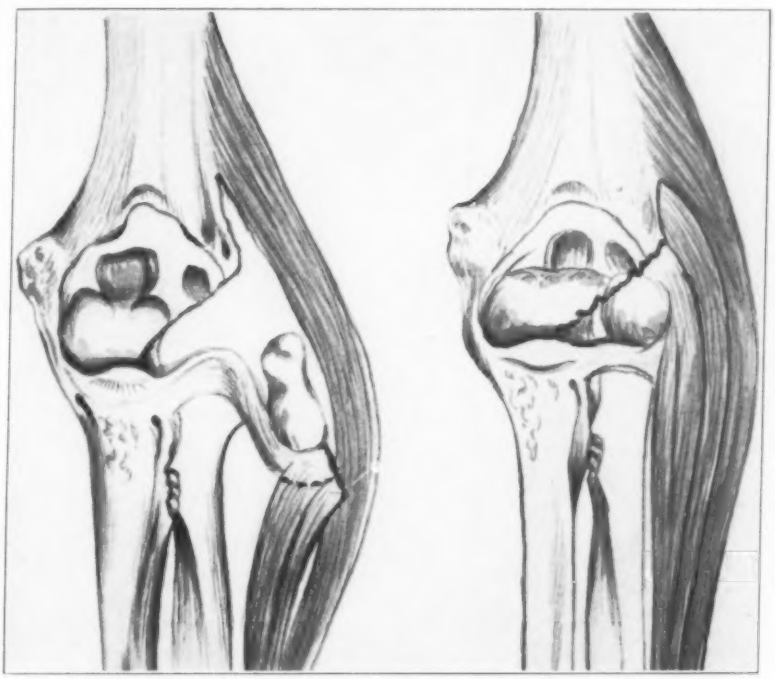

FIG. 1-A FIG. 1-B

Drawings illustrate capitellar fractures.

FIG. 1-A: The fracture occurred above the origins of the extensor carpi radialis longus and extensor carpi radialis brevis. The displacement of the fragment is shown. Note that the upper end of the lower fragment is pulled down and is pointing downward, slightly backward, and outward, while the lower end is directed medially and upward.

FIG. 1-B: The fracture occurred beneath the origins of the extensor carpi radialis longus and extensor carpi radialis brevis. Only the line of fracture, not the displacement, is shown. Usually the lower fragment is displaced slightly outward and upward.

TABLE I

RÉSUMÉ OF FRACTURES OF THE LATERAL CONDYLE

| Case No. | Year | Sex | Age (*Years*) | Cause and Site of Injury | Duration | X-Ray Findings | Treatment | Result |
|---|---|---|---|---|---|---|---|---|
| 1 | 1931 | Male | 10 | Fall from a height on outstretched hand. Left elbow. | 20 Days | Capitellar fracture of the lower end of the humerus with slight displacement upward and laterally. | Manipulated under anaesthesia and the flexed elbow put in plaster. | Functional result good at time of discharge. |
| 2 | 1931 | Female | 50 | Fall from a height. Right elbow. | 1 Day | Condylar fracture with backward displacement of the condyle. | Under anaesthesia elbow was flexed and put in plaster. | Result not known. |
| 3 | 1934 | Male | 51 | Accident when 7 years of age. Left elbow. (Admitted for cubitus valgus deformity and non-union of old capitellar fracture with ulnar paralysis.) | Ulnar paralysis for 3 years before admission. | Old capitellar fracture with non-union. | Ulnar transposition was advised, but patient refused operative interference. | Invalided out of service. |
| 4 | 1937 | Female | 7 | Fall from a staircase. Left elbow. | 1 Day | Capitellar fracture with displacement of fragment. | First admission: Arm put in extension in a Thomas arm splint and after 3 days the elbow was manipulated and put in flexion in plaster.<br>Second admission: Ulnar anterior transposition of the nerve. | Fair at time of discharge, with flexion to 60 degrees and extension to 130 degrees.<br>Readmitted after 2 months for non-improvement of range of movement at the elbow and a trophic ulcer on the tip of the little finger.<br>After the operation there was remarkable improvement in the range of movement of the elbow. One year later elbow appeared normal except for a slight exaggeration of cubitus valgus deformity. |
| 5 | 1937 | Male | 12 | Fall on outstretched hand after a pull. Left elbow. | 1 Day | Capitellar fracture without displacement. | Elbow manipulated and put in flexion in plaster. | Good at time of discharge. |
| 6 | 1937 | Male | 11 | Fall while riding a bicycle. Left elbow. | 2 Days | Capitellar fracture with a somersault of the fragment in the elbow joint. | Arm put in extension in a Thomas arm splint and after 3 days the elbow was manipulated and put in flexion in plaster. | After one year slight limitation of extension and slight exaggeration of cubitus valgus deformity. No involvement of ulnar nerve. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7 | 1937 | Female | 7 | Fall from a height. Right elbow. (Admitted with a cubitus varus deformity with slight limitation in extension and flexion.) | 3 Months | Old fracture of the capitellum with malunion of the fragment. | Advised weight-bearing exercises and massage. | Cubitus varus deformity. |
| 8 | 1937 | Male | 4 | Fall from a bus. Left elbow. | 1 Day | Capitellar fracture with slight displacement of fragment. | Elbow manipulated under an anaesthetic and limb put in flexion in plaster. | Functional result good at time of discharge. |
| 9 | 1938 | Male | 4 | Fall from a staircase. Right elbow. | 3 Days | Capitellar fracture with a somersault of the fragment in the joint. | Arm put in extension in a Thomas arm splint and after 3 days the elbow was manipulated and put in flexion in plaster. | Good. |
| 10 | 1938 | Male | 11 | Fall from a tree. Left elbow. (Admitted for limitation of flexion.) | 2½ Months | Malunion of capitellar fracture. | Ulnar anterior transposition of nerve, manipulation, and elbow put in plaster in flexion. | Slight exaggeration of cubitus valgus deformity. Stated in letter that function is good. |
| 11 | 1938 | Male | 30 | Fall from a height. Right elbow. | 10 Days | Condylar fracture with slight upward and lateral displacement. | Extension of elbow by skeletal traction by Kirschner's wire for 4 weeks, and then gradual active flexion with plaster casing at each stage of flexion to prevent effusion until acute flexion is obtained. | Four months after treatment there was flexion of 60 degrees and extension of 130 degrees. |
| 12 | 1938 | Male | 12 | Fall from a tree. Right elbow. (Admitted for limitation of movements at elbow with marked new bone formation.) | 4 Months | Malunion of fragment with marked new bone formation simulating myositis ossificans. | Manipulated under anaesthesia and limb put in flexion. | Slight exaggeration of cubitus valgus deformity. Reported after one year that result was good. |
| 13 | 1939 | Male | 7 | Fall from a bench. Right elbow. | 2 Days | Capitellar fracture with marked displacement. | Arm put in Thomas extension splint for 2 days until the swelling subsided. Later, under ethyl chloride ether anaesthesia, the fragment was manipulated into position and the limb put in plaster. | At time of discharge there was flexion to 40 degrees, extension to 120 degrees. Subsequently by letter stated that the movements at the elbow were normal. |

DIAGNOSIS

The signs and symptoms are like those of any other supracondylar fracture, with the important physical sign of swelling being more marked on the lateral aspect of the elbow joint. When the patient seeks advice twenty-four hours after the occurrence of the fracture, the diagnosis be-

FIG. 2-A

FIG. 2-B

Case 4. October 28, 1937. A capitellar fracture with a displacement similar to that in Fig. 1-A.

FIG. 2-C

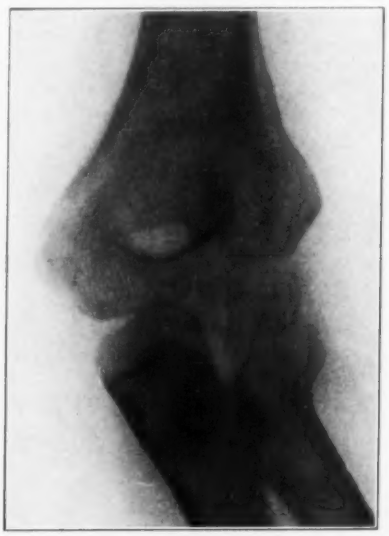

FIG. 2-D

Case 4. October 28, 1937. The result immediately after closed reduction.

FIG. 2-E

FIG. 2-F

Case 4. June 19, 1938. Photographs show the increased range of flexion and extension after ulnar transposition. Note the slight cubitus valgus deformity.

comes difficult because of the swelling, but when that subsides, it is easy to palpate the displaced fragment under the skin. This is a valuable help during the manipulation of the fragment into position. A perfect diagnosis can be made from the roentgenograms.

FIG. 3-A

FIG. 3-B

Fig. 3-A: Case 6. October 18, 1938. Capitellar fracture with severe displacement similar to that in Fig. 1-A.
Fig. 3-B: November 19, 1938. Result of reduction by closed method.

## TREATMENT

Various views are held with regard to the treatment of this fracture, and the following methods have been advocated:

1. Closed reduction of fragments,—a method of treatment just mentioned in passing.

2. Open reduction and pegging of the fragment to the diaphysis,—universally accepted as the method of choice.

3. Operative removal of the fragment, if it is malunited, or if non-union has occurred which interferes with the movement of the joint.

Wilson [6] has stated: "A rare case has been reported, in which a rotated fragment was replaced by closed manipulation, but this method fails so uniformly that the author considers it folly even to attempt it."

Though operative fixation is the accepted treatment, the object of this paper is to show that closed reduction has a definite place in the treatment of this condition.

Every case in this series was associated with a large effusion, and the first step was to reduce the swelling by putting the limb in extension in a Thomas arm splint with a firm bandage around the elbow, not interfering with circulation. The subsidence of the swelling occurred in two or three days after rest in extension, and the displaced fragment could be easily palpated under the skin.

FIG. 4-A

Case 13. October 23, 1939. Capitellar fracture with marked displacement of the fragment.

Under an anaesthetic the extended limb is slowly flexed to a right angle, maintaining extension and counterextension at the elbow, with the thumb giving a steady upward pressure against the upper end of the lower fragment, which is pointing downward because of the displacement. This manoeuvre has a double effect. The extension and counterextension disengages the lower fragment and prevents its hitching against the diaphyseal lower end of the humerus; and the steady upward pressure guides it toward the lower end of the upper fragment. At the same time the flexion at the elbow is increased with marked pronation of the forearm. Sometimes it is necessary to abduct the forearm slightly in supination and press down the upward tilt of the

FIG. 4-B

Case 13. October 23, 1939. Roentgenogram taken after reduction, with the cast in place.

fragment. A definite click at this stage indicates the reduction of the fragment and the movements become freer at the elbow. On no account should the movements be tried over a longer range, especially in supination.

When it is felt that the reduction is complete, a plaster strip four inches wide is applied gently to the skin (enclosing the posterior segment of the circumference and lower two thirds of the upper arm, including the flexed elbow), is molded to the shape of the posterior aspect of the arm and over the supracondylar ridge, and is allowed to set. Next a similar strip is applied from the posterior aspect of the lower two thirds of the upper arm to the proximal part of the wrist. This plaster strip covers the posterior aspect of the lower two thirds of the arm and the forearm on either side of the ulnar border. A cotton pad about one inch in thickness is cut to the required size, is put in front of the elbow, and extends from the lower two thirds of the upper arm to two inches below the crease of the elbow. A strip six inches wide, extending from the upper arm to the limits of the pad below the elbow crease, is laid in front of the elbow, gently

FIG. 4-C

Case 13. October 25, 1939. Clinical photograph with the plaster splint applied.

molded, and allowed to set. Another strip four inches wide is laid in front of the forearm—with the wrist in dorsiflexion to relax the extensors of the wrist—and ends in the palm just proximal to the proximal crease. A circular plaster bandage is then applied to strengthen the plaster (Fig. 4-C).

It must be definitely ascertained before the application of the plaster that there has been no primary nerve lesion; and after reduction of the fragment and flexion of the elbow the radial pulse must be quite palpable. The patient is advised to report the next day for a roentgenogram of the elbow, and the limb is examined carefully for any complications which may arise.

If the fragments have been reduced properly, the plaster is removed at the end of three weeks, and the elbow kept in flexion in cuff and collar. At the end of the fourth week, if the fragments are found to be firmly united, active movements and gentle massage are begun. No passive movements are ever permitted in the region of the elbow, and it is better if, in the beginning, these active movements are made under the direction of the surgeon. It must be made clear to the patient's parents that extension at the elbow will come with time, but flexion is the movement that has to be conserved. The rule which applies to the after-treatment of all elbow injuries, in connection with the restoration of function, is "to make haste slowly". Aided and resisted exercises are permitted, to improve the weight-bearing capacity, when the surgeon is convinced of the firm union of the fragments.

## COMPLICATIONS

### *Malunion and Non-Union*

There were four cases of malunion, the most common complication, and one case of non-union. The result of malunion was an exaggerated cubitus valgus deformity in three cases, and cubitus varus deformity in one. In the three patients with cubitus valgus deformity, there was limitation in flexion and extension with definite impairment of function. In one, as a result of forced movements done outside to restore function, marked new bone formation developed simulating clinically myositis ossificans (Case 12). In this case the limitation of flexion and extension was remarkable. The patient was treated by manipulation under anaesthesia; the elbow was placed in acute flexion and subsequent plaster casing to give it rest. After four weeks the plaster was removed, the elbow was supported by cuff and collar, and active movements and massage were instituted. The boy has regained a useful elbow. In the other two cases flexion was more limited than extension. In the case of cubitus varus deformity in a girl of seven (Case 7), the flexion and extension were within the functional range of the elbow, so no surgical interference was advocated, though the aesthetic appearance of the elbow was not satisfactory.

*Involvement of Nerves*

As a result of cubitus valgus deformity, which often results after this fracture, the ulnar nerve was found to be involved in two cases (Cases 3 and 4). The cause of the limitation of movement at the elbow was brought home accidentally to the author from the experience gained in Case 4. In this case perfect reduction was obtained (Figs. 2-A, 2-B, 2-C, and 2-D), and at the time of discharge a very good functional result was noted. The patient was again brought to the clinic by the mother who stated that the range of flexion had not improved. On examination it was found that in addition to the failure of improvement in flexion, the patient had developed a trophic ulcer on the tip of the little finger with loss of sensation over that finger. The mother was more concerned with the limitation of flexion than with the ulcer as it was painless. To save the nerve, ulnar transposition was done, and it was found after the operation that the range of flexion improved along with recovery of sensation in the area supplied by the ulnar nerve (Figs. 2-E and 2-F). This instance helped the author to understand the limitation of flexion in such cases. It was probably brought about by the protective spasm of the triceps and flexors to prevent the overstretching of the ulnar nerve in acute flexion.

The other patient (Case 3) had a late involvement of the ulnar nerve associated with non-union of the fragment. The accident had occurred when the patient was a child of seven, and weakness of the palm had existed for three years before admission to the Hospital. The patient had typical ulnar paralysis; transposition of the ulnar nerve was advised, but refused, and he was invalided out of the service.

Case 10 was treated by ulnar transposition with marked improvement in the movements of the elbow.

*Deformity*

A slight cubitus valgus deformity develops even in cases where roentgenographically the fragments appear well set. This is not a great inconvenience, but the patient should be warned that if tingling or loss of sensation develops over the little finger, he should seek surgical advice, with a view to having the ulnar nerve transposed to prevent ulnar neuritis and ulnar paralysis.

## CONCLUSIONS

1. Fractures of the lateral condyle in children are known as capitellar fractures, and, when they occur above the origin of the extensors, are accompanied by marked displacement of the lower fragment, causing it to turn over.

2. Closed reduction has given satisfactory results in those patients who sought advice soon after the accident. The main principles are reduction of the effusion, and then the manipulation of the lower fragment into position with the elbow in flexion and the forearm in pronation. If

the forearm is supinated it is found that the gap between the fragments after reduction becomes greater.

3. In the cases which were not treated properly, malunion caused limitation of movements at the elbow. In two cases ulnar transposition improved the functional movement of the elbow; and in one case, with marked new bone formation, rest in flexion improved the functional movement.

4. A slight exaggeration of cubitus valgus deformity has been the rule even in cases with a good roentgenographic apposition and union of the fragments.

The author wishes to thank Dr. P. Kesavaswami, L.M.S., the Roentgenologist, and Dr. T. Mathew, M.B., of the Department of Anatomy, who helped in the experiments on the cadaver.

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# HISTOPLASMOSIS OF THE KNEE

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Histoplasmosis or reticulo-endothelial cytomycosis is a generalized disease which varies widely in its clinical characteristics, and is caused by the histoplasma capsulatum of Darling. This organism was discovered by Darling in 1906 while he was searching for evidence of kala-azar in smears from the spleen, liver, and bone marrow of all patients showing splenomegaly, who came to autopsy at the Ancon Hospital. Darling noted the similarity of the organism to the Leishman-Donovan body of kala-azar, but pointed out that it differed from this in the form and arrangement of the chromatin of the nucleus, and in that it did not possess a blepharoplast.

Meleney, in a review of the subject, notes that no further cases were recorded until 1925 when a case was discovered in Minnesota; in his paper he reviews the nineteen cases in the literature, and adds thirteen new cases. He states that while the disease is rarely diagnosed, it is probable that it is considerably more frequent than is supposed, that it is widely distributed throughout the world, and that it will undoubtedly be recognized with increasing frequency in the future. He finds that the disease may present one of the four following clinical pictures:

1. A systemic febrile disease similar to kala-azar, with an enlarged liver and spleen, septic temperature, anaemia, and leukopenia;

2. Lymph-node enlargement may predominate, simulating Hodgkin's disease, leukaemia, lymphosarcoma, or aplastic anaemia;

3. Pulmonary symptoms may predominate. The infection is often complicated by, or superimposed upon, pulmonary or generalized tuberculosis;

4. The infection may begin as a small skin lesion which may sometimes develop into a generalized ulcerative skin condition.

The organism as found in the tissues is round or oval in shape and measures from one to four micra in diameter. It has a deeply staining, basophilic central mass or chromatin nucleus which may be round, ovoid, or semilunar in shape. This is surrounded by a clear space, which in turn is surrounded by a refractile achromatic rim. This is the yeastlike form of the fungus.

Darling believed that it was a protozoan parasite. DeMonbreun has cultured the fungus from a patient dying of the disease, and has reproduced the disease in susceptible animals (monkeys). He has also grown the organism on artificial media, and has described and pictured both the yeastlike form which occurs in the tissues, and the vegetable form which

occurs on culture media, and has traced the transformation of the yeastlike fungus to the mycelian form.

In so far as the authors have been able to determine, none of the cases in the literature presented any involvement of the joints or muscles. Recently one of the authors has had under his care a patient from whom the sections from the specimen of the knee joint showed the typical histoplasma capsulatum of Darling. The case is being reported because it is believed to be the first instance in which the disease has been known to involve a joint, and also because the case closely resembled tuberculosis of the knee joint, and was so diagnosed until it was found that the guinea-pig inoculation and the tuberculin test on the patient were negative. It was then thought to be a low-grade infection of unknown origin. The limb was amputated and the correct diagnosis was arrived at only when it was made by Dr. Robert A. Moore of the Department of Pathology, to whom the slides from the tissues were submitted. The case report is as follows:

W. A. S. (Barnes Hospital History No. 89485), a white male, aged forty-seven years, was admitted to the Medical Ward on May 14, 1941, with a history of aching pain and disability in the left knee of seven months' duration. The past history was unimportant. The personal history revealed that the patient had been born in southeastern Missouri, and had lived there on a farm all of his life. He had stopped school at the age of nineteen

FIG. 1-A

May 5, 1941

FIG. 1-B

June 24, 1941

Histoplasmosis of the knee.

years, at which time he was in the fifth grade. He had never been strong, but had done some light work on the farm. The pain in the knee developed gradually, and was not preceded by any definite injury. The knee became swollen and stiff. The pain increased and was aggravated by movement. It was described as dull and constant in character, except with movement, when it became more intense. He had tried various forms of liniment and local heat, and had had some osteopathic manipulations which seemed to make the knee worse.

At the first admission the patient was walking, but with a marked limp and with considerable pain. On physical examination the temperature was 38.5 degrees centigrade, the pulse was 80, respiration was 22, and the blood pressure was 120/76. The patient was a small, poorly nourished white male who looked older than his stated age. Examination of the skin revealed a large number of papillomata over the body, and especially over the face, neck, and thorax. The clinical diagnosis was neurofibromatosis, which was subsequently confirmed by biopsy of the papillomata. Other than the neurofibromatosis and the arthritis of the left knee, the general examination was negative.

The left knee was held in a position of moderate flexion, and the patient objected to its being moved, only a few degrees of movement being permitted because of pain and muscle spasm. On inspection the knee was considerably enlarged, being about half again as large as the other knee. The enlargement was symmetrical, the synovial cavity was distended, and the knee joint contained excess fluid. Also, the periarticular tissues were thickened. There was moderate increase in local heat over the knee joint, and on deep pressure it was moderately tender. There was no redness. The medical diagnosis was (1) infectious arthritis; (2) neurofibromatosis; and (3) mental deficiency.

Roentgenograms of the left knee and chest were taken. The lateral view of the knee joint showed thickening of the soft tissues and moderate bone atrophy with spotty atrophy of the bone structure. The anteroposterior view showed spotty atrophy and no

FIG. 2-A FIG. 2-B

Histoplasmosis of the knee.

May 5, 1941 June 24, 1941

decrease in the joint space, and in neither view was there any evidence of new bone formation. The chest film showed rather well-defined rounded areas of almost complete opacity measuring seven by seven centimeters in the lower half of each lung field between the fourth and sixth ribs anteriorly. Although these areas had an appearance suggestive of encapsulated interlobar collections of fluid, roentgenographic diagnosis was deferred.

Laboratory findings showed:

Red blood cells—4,890,000

White blood cells—12,250

Segmented polymorphonuclear neutrophils—79 per cent.

Non-segmented polymorphonuclear neutrophils—6 per cent.

Polymorphonuclear basophils—1 per cent.

Lymphocytes—11 per cent.

Mononuclears—3 per cent.

Kahn test—negative

Gonococcus fixation test—negative

Urinalysis—normal

The patient remained in the Hospital and was treated with sulfathiazole on the basis that possibly this was pyogenic arthritis. He was given one gram of the drug every four hours for six days. However, during this period there was no improvement in the knee, and the temperature ranged between 37.5 and 38.5 degrees centigrade. He was then seen in consultation by one of the authors, who made a tentative diagnosis of tuberculosis of the left knee. The knee was aspirated and the fluid, which was thick purulent material, was cultured and was inoculated into a guinea pig. At this time the patient refused surgery or immobilization of the knee, and he went home on May 29, 1941. The culture of the pus was sterile. The guinea pig subsequently was killed and showed no evidence of tuberculosis.

The patient returned to the Hospital on June 23, 1941, on the Orthopaedic Service, and stated that his knee had become increasingly painful and stiff, and that he wanted the leg amputated.

At this time the patient was not able to walk or bear weight on the extremity. On physical examination the knee was markedly swollen, very tense, moderately tender, and exquisitely painful on movement. The local temperature of the skin over the joint was moderately elevated. Not only was the entire region of the knee joint swollen, but there was considerable swelling of the calf, which too was tense, tender, and fluctuant. The white-blood-cell count was 16,400, and the red-blood-cell count was 3,636,000. New roentgenograms showed increased density of the synovial tissues, increased atrophy of the bone, some narrowing of the joint space, and marked broadening and erosion of the margins of the intercondylar notch.

The joint was aspirated, and about ten cubic centimeters of very thick, white purulent material was withdrawn. The pus was so thick that great difficulty was encountered in withdrawing it, even with an 18-gauge needle. The leg was immobilized on a splint, and the patient was put on a high caloric diet in an effort to build him up for operation.

At this time, it was felt that this was probably a low-grade pyogenic infection, or possibly a fulminating tuberculosis of the knee, since the culture of the pus was again negative. It was believed that the amount of destruction which had occurred over the four-week period was too great to be explained by an ordinary tuberculous infection. (The negative report from the guinea-pig inoculation at the previous admission had not yet been obtained.) After talking the matter over with the patient's family, it was concluded that the extremity should be amputated. An amputation through the middle and lower thirds of the thigh was performed on June 28, 1941; sulfathiazole powder was placed in the wound; it was closed without drainage; and traction was applied to the stump. The patient was quite comfortable after the operation, and the wound healed by primary intention.

The sutures were removed on the seventh postoperative day. Two days later the patient became stuporous and cyanotic, and the neck became rigid; he developed ankle

clonus, and was obviously quite sick. Examination of the chest showed dullness to percussion, increased breath sound, and myriads of fine râles over the lower lobe of the right lung. The peripheral veins were quite distended. The patient was seen by Dr. Leo Gottlieb who made a diagnosis of right-lower-lobe pneumonia, complicated by right heart failure and meningismus. Lumbar puncture was negative, with the exception of a moderate increase in the protein in the spinal fluid. He was placed in an oxygen tent and was given sodium sulfathiazole intravenously. He died on the following day. Autopsy was refused, and the true diagnosis was not suspected until the microscopic sections of the synovial tissues of the knee were examined.

*Pathological Findings*

On gross examination of the specimen, the knee was found to be considerably enlarged. The synovial cavity was converted into a large abscess cavity which was filled with thick gray purulent material; the abscess extended into the calf of the leg. The articular surfaces of the bones showed considerable erosion and necrosis, and, grossly, the specimen resembled advanced tuberculosis of the knee. The synovial tissues were markedly thickened and covered with a grayish-white exudate.

*Microscopic Examination*

Sections from three areas of the joint were studied: (1) the fibrous tissue of the synovial membrane; (2) the cellular layer of the synovial surface; and (3) the cortex of the femur beneath the synovial surface. Examination of these sections revealed the following:

1. The fibrous portion of the synovial surface showed relatively little reaction, and

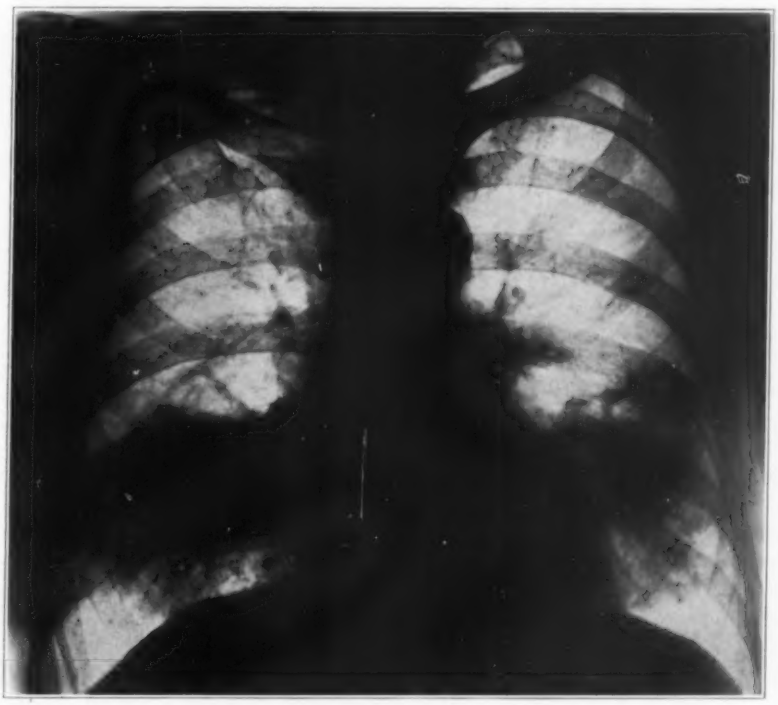

FIG. 3

Roentgenogram showing chest of the patient with histoplasmosis. It is believed that the opaque areas in each lower lobe are due to the infection. At this time no physical signs were detected.

the dense fibrous tissue was, as a rule, not invaded by the inflammatory process, although a few monocytes which contained one or two organisms were seen beneath the surface, and there was a slight amount of proliferation of the surface cells.

2. The cellular portion of the synovial surface was markedly thickened, and was composed of a mass of mononuclear cells embedded in a youthful connective-tissue

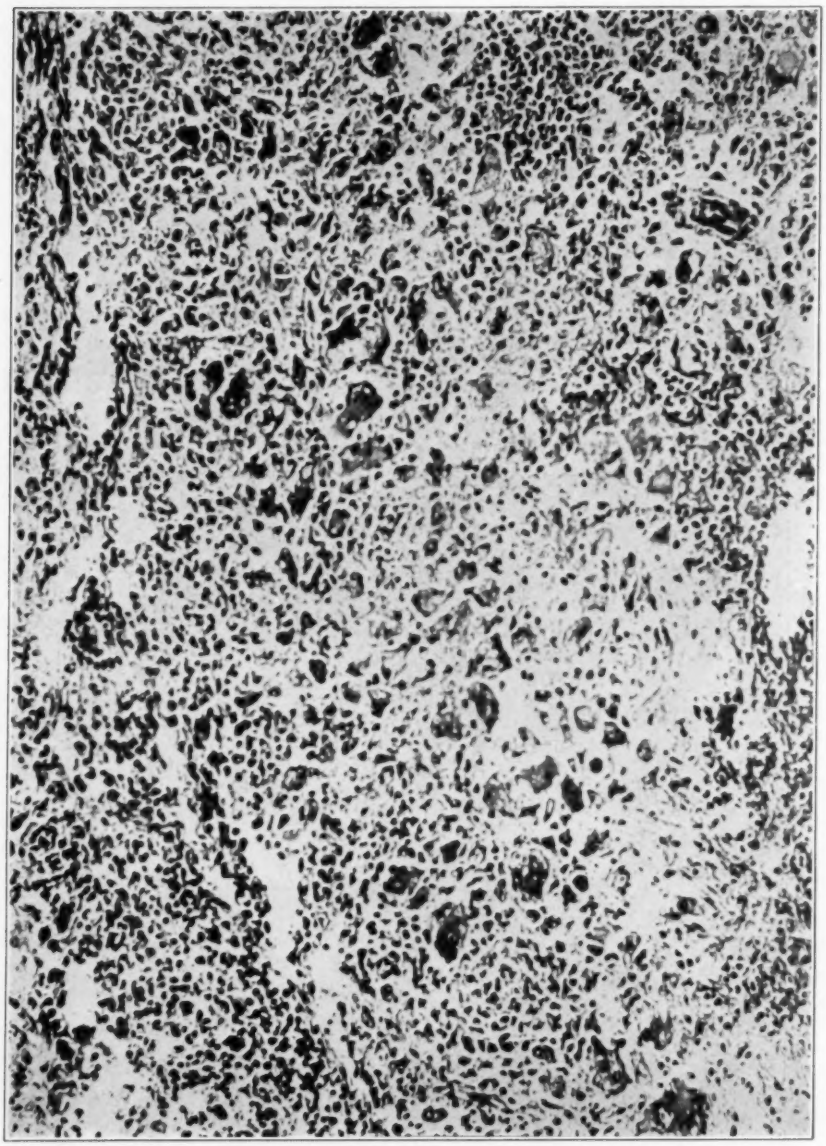

FIG. 4-A (× 165)

Photomicrographs of synovial tissue. (See also Figs. 4-B, 4-C, and 4-D.) Note giant cells, the nuclei of which are, for the most part, not visible. The histoplasma capsulatum of Darling are the small clear spherules, with the deeply staining body or nuclei, which are seen within the bodies of the giant cells.

network. The blood vessels were moderately increased in size and number. The synovial membrane was transformed into a mass of granulation tissue, which was intensely infiltrated with macrophages and giant cells, and was characterized by the presence of numerous areas of focal necrosis which resembled the caseation found in tuberculosis. In these areas there were degenerating cells and numerous giant cells, some of which also were degenerating. The great majority of the cells in the inflammatory exudate were mononuclear phagocytes or monocytes. Many of the phagocytic cells contained minute spherical bodies which varied in size from three to five micra in diameter. These bodies possessed a clear cytoplasm which was surrounded by a refractile ring and contained a

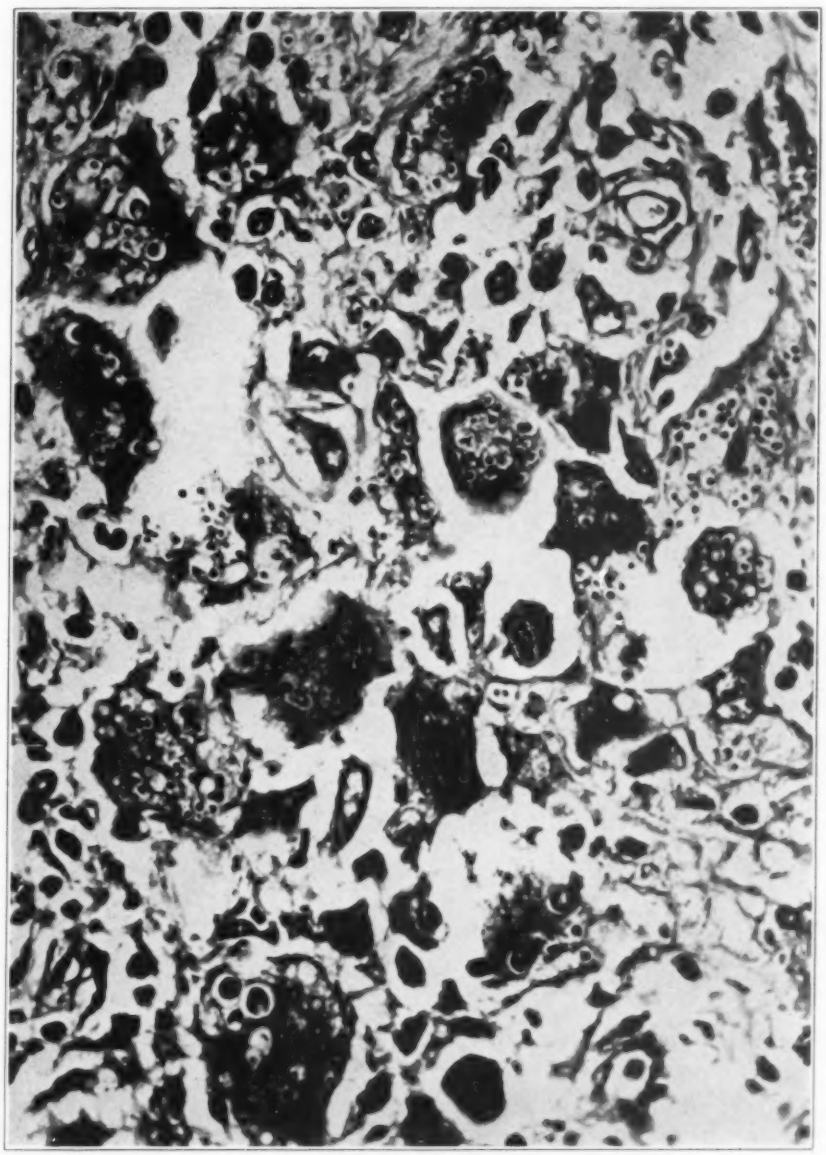

FIG. 4-B (× 650)

deeply staining central mass or nucleus which was usually spherical, but might be irregularly ovoid or semilunar in shape, and was about one-half the diameter of the parasite. These were the histoplasma capsulatum of Darling. In some areas the parasites were present in enormous numbers, and crowded the bodies of the large macrophages and giant cells. Where these cells were burst or degenerating, the parasites were free in the tissues or in the necrotic debris, but for the most part they lay in the cells. Relatively few of the monocytes contained any other phagocytized material, and very few of them contained red-blood cells. The endothelial cells or monocytes merged into the phagocytes, and these, in turn, merged into the giant cells which varied greatly in size; some of them

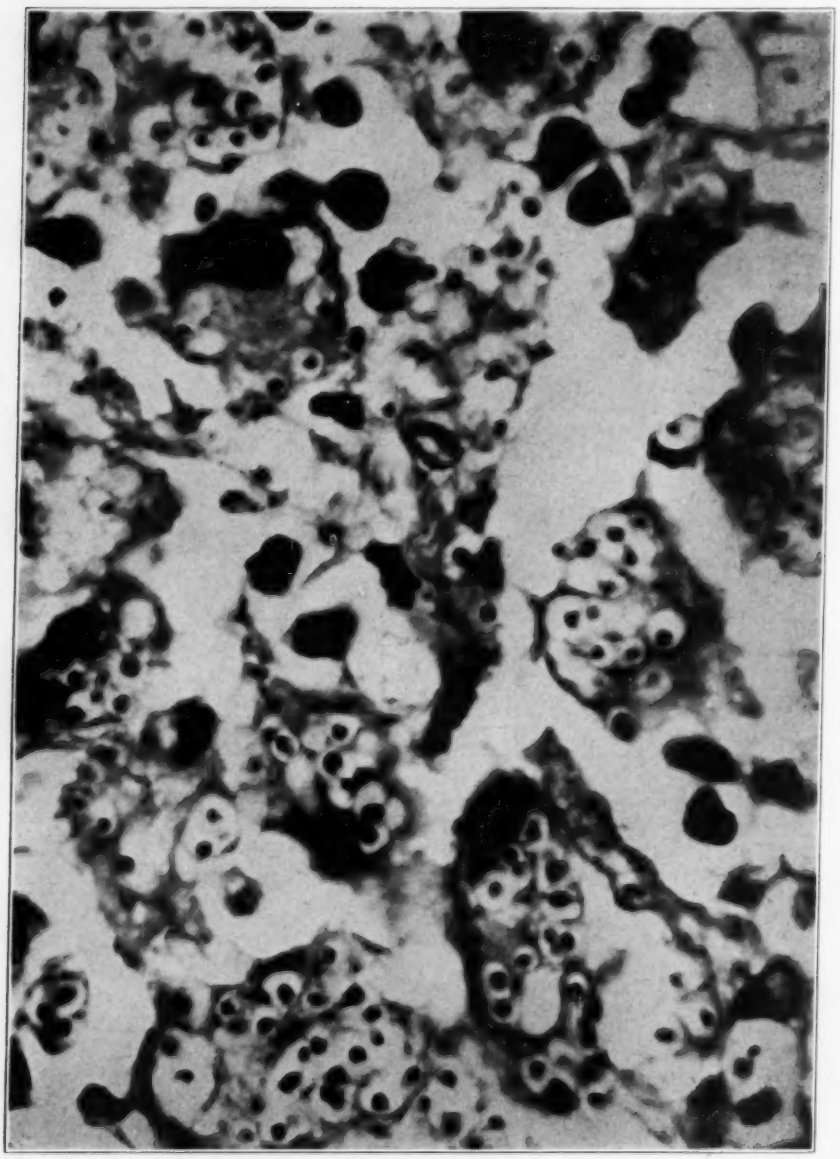

FIG. 4-C (× 1380)

contained fifty or more nuclei and resembled foreign-body giant cells. There was a striking absence of polymorphonuclear leukocytes in the diseased areas of the tissue.

The pathological picture resembled that of a tuberculous synovial membrane, except that there were no tubercles and the giant cells were of the foreign-body type. When the sections were stained for acid-fast bacilli, no organisms were seen.

The synovial surface was covered with an exudate which contained many well-preserved cells, mostly mononuclear phagocytes and small round cells (probably lymphocytes and plasma cells). It also contained a considerable number of giant cells, some of which were quite large, exhibiting thirty-five or more nuclei in a single five-micron sec-

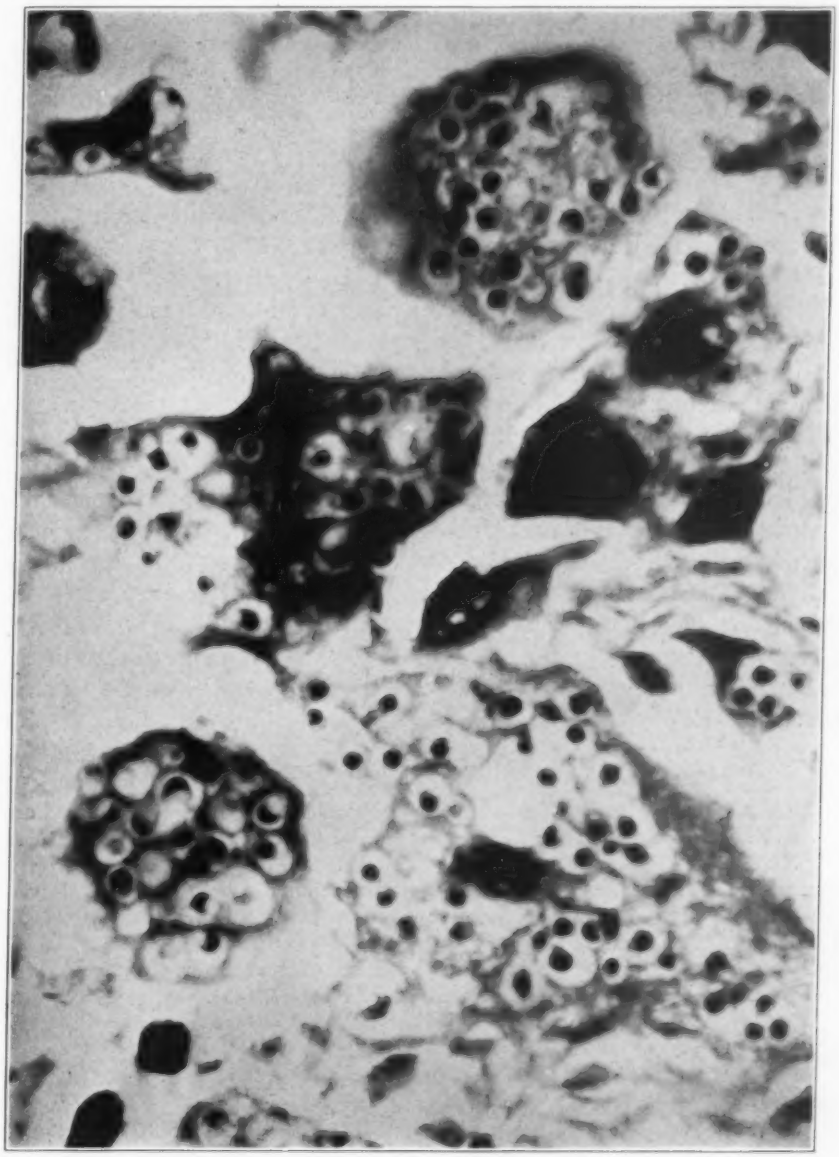

FIG. 4-D (× 1730)

tion. In some areas the exudate was composed of a mass of fibrin and of necrotic cells. In the bodies of the mononuclear phagocytes and of the giant cells in the exudate, there were large numbers of the yeastlike organisms. Some of these organisms were free in the coagulated exudate, but, for the most part, they were intracellular.

3. The invasion of the bone was also similar to that which occurs in tuberculosis. The infected inflammatory tissue extended down through the nutrient canals of the cortex and spread out in the bone-marrow spaces. The trabeculae in the bone marrow tended to be eroded by the granulation tissue, and showed little or no tendency to the production of new bone. Likewise, the bone was not killed by the juxtaposition of the infected granulation tissue. Outside of the areas where the bone marrow had been invaded through the nutrient canals, the cancellous bone and marrow appeared to be normal and no organisms were found in this tissue. They were, however, quite numerous in the cells of the granulation tissue which had invaded the bone marrow, but were not so numerous as they were in the inflammatory tissue of the cellular portion of the synovial surface.

## DISCUSSION

In looking back over this case, the appearance of the lesions in the lungs, which were probably caused by the fungus (Figs. 4-A, 4-B, 4-C and 4-D), and the course of the disease in the knee, and physical and laboratory findings should have led to the suspicion of a fungus infection instead of, first, tuberculosis, and later, a low-grade pyogenic infection in the knee. Naturally, the authors are not proud of their record, but feel that this case should be recorded because, if Meleney's predictions come true, other cases will appear, and it is probable that other clinicians will make similar mistakes.

However, even had an early diagnosis been arrived at, it is probable that the fatal outcome of the disease could not have been avoided, because, with two exceptions, in all of the cases recorded in the literature, the patients have died of the disease. Meleney believes that antimony preparations may offer hope of cure. His paper should be consulted by those wishing to learn more of the disease. It is to be noted that in this patient the administration of full doses of sulfathiazole had no beneficial effect.

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# TREATMENT OF CONGENITAL TALIPES EQUINOVARUS WITH A MODIFICATION OF THE DENIS BROWNE METHOD AND SPLINT *

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A wide provincial practice is enjoyed at our weekly Club-Foot Clinic, so that no fewer than twenty-five to thirty new cases are seen each year, with an average of ten patients each week.

Until two and a half years ago manipulation and plaster was the method of treatment. This was done without anaesthesia at intervals of two to three weeks and finally the equinus was corrected by a subcutaneous tenotomy under anaesthesia. A club-foot splint was then provided, and the parent was instructed to carry out daily stretching.

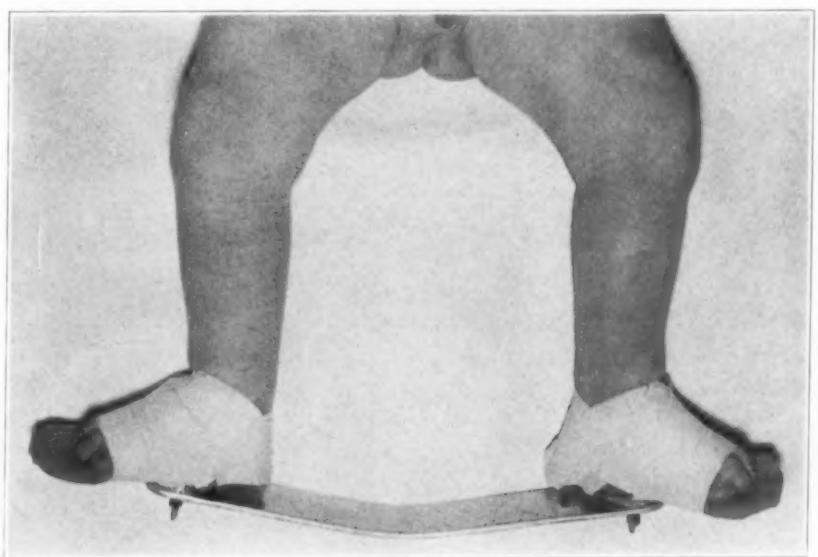

FIG. 1

A discouraging rate of recurrence persisted with this method. The difficult problem that a recurrent club foot presents need not be elaborated upon except to say that eventually many of them require an arthrodesis at an undesirably early age.

Two and a half years ago the author was attracted by the simplicity of the Denis Browne method [1] and since its application the results have been most gratifying. Sixty new cases of the equinovarus variety have

* Presented at the Clinical Session of the Annual Meeting of The American Orthopaedic Association, Toronto, June 9, 1941. Received for publication July 30, 1941.

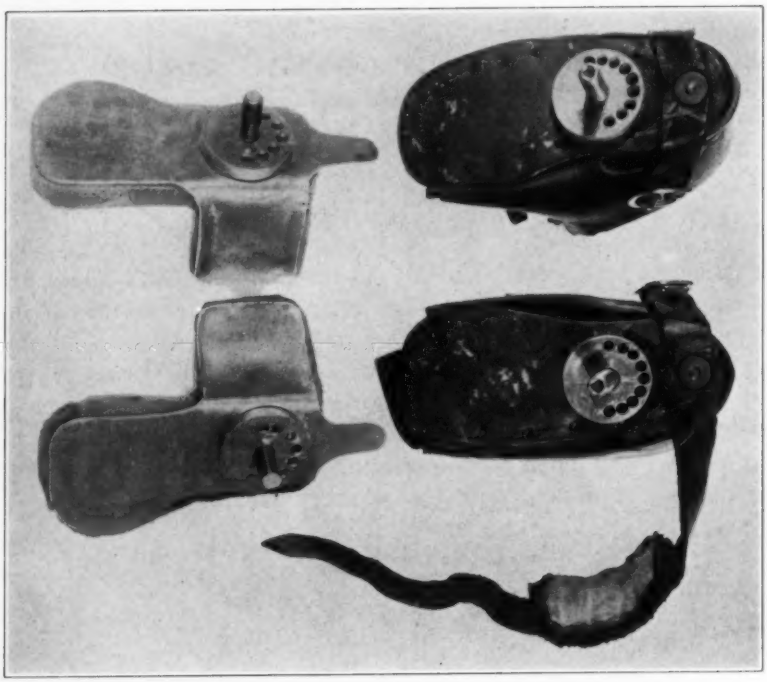

FIG. 3

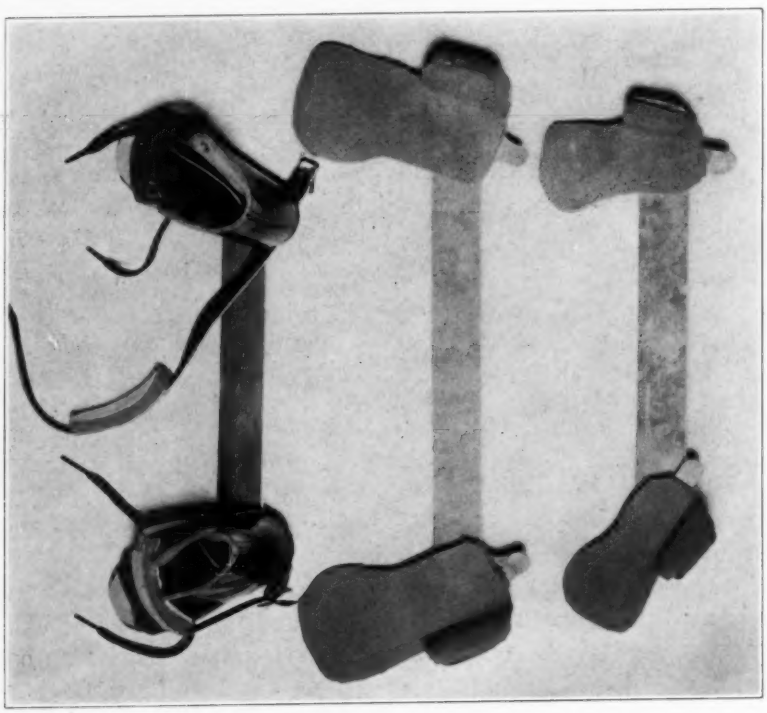

FIG. 2

been treated, and only one definite recurrence has been discovered. The blame for this is entirely credited to the mother, who abandoned all care of the feet for over two months. This occurred during the third phase of the treatment,—namely, the stage of boot splints.

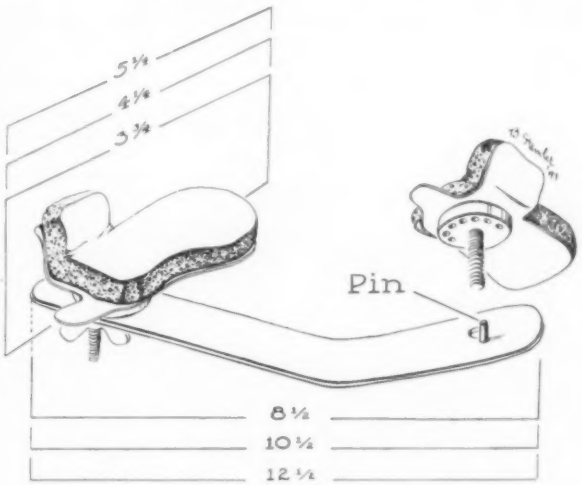


FIG. 4

Modification of Denis Browne splint for club feet.

The author prefers to start treatment during the first month of life, usually at about three weeks of age. The oldest untreated patient was one year of age and the child responded just as rapidly with a most satisfactory correction.

The principle of treatment for the correction of deformity is to strap the feet to the splint, which has a connecting cross bar, and then let the infant correct its deformity by incessant kicking (Fig. 1).

For the sake of convenience, the treatment is divided into four phases (assuming that it is started during the first few weeks of life):

(1) The phase during which the deformity is corrected and carried into over-correction (usually five to six weeks' duration).

(2) The phase of maintaining the correction in the same adhesive splints (approximately five months or even less, if the feet are large enough).

(3) A further period of maintaining correction by the use of boot splints (about six months' duration or until walking commences).

(4) The period during which the boot splints are used as night and resting splints, and supplemented with special walking boots during the active periods of the day. The duration of this phase will have to be decided upon in the future, but should be carried on for at least two to three years. It will depend upon the cooperation of the parents and the diligent observation of the doctor. It is suspected that most recurrences will appear in this phase, as it has done so notoriously with former methods of treatment.

The splints which are used for correcting the deformity are made in three standard sizes (Figs. 2 and 3), the largest being used for old recurrent cases. Duralumin, one-sixteenth of an inch thick, is used for the two larger sizes, and aluminum, one thirty-second of an inch thick, for the smallest size. There is an upright projection on the outer side which

reaches the upper limit of the malleolus. An important feature is the posterior narrow projection for anchoring the adhesive and so keeping the heel down in place. The splint is covered with sponge rubber. On the under side is a bolt (Fig. 3), with a circular metal washer at its base which contains a series of holes. A pin in the cross bar fits into the desired hole, making the position secure and easily recorded from week to week.

FIG. 5

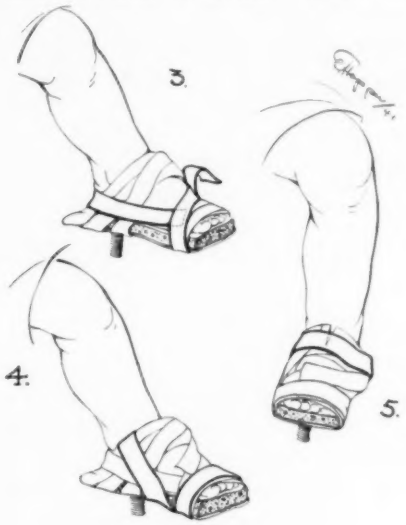


FIG. 6

An effective method of taping the foot in the Denis Browne splint.

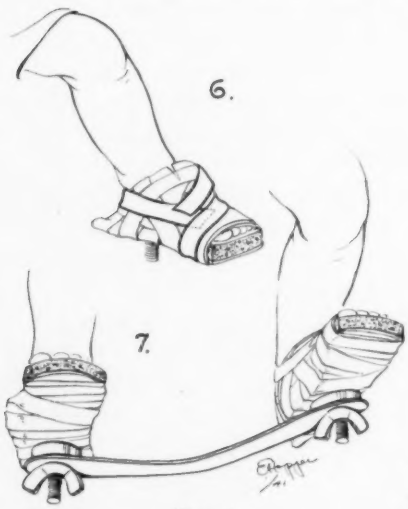


FIG. 7

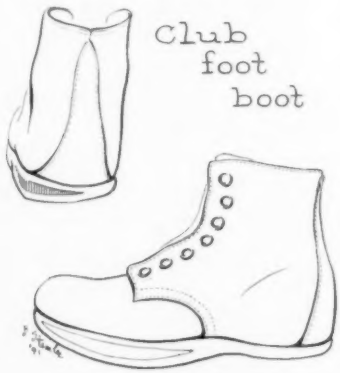


FIG. 8

Club-foot boot.

When treatment is started at an early age (three to four weeks), weekly visits are required for the first four to six weeks and then every two weeks thereafter. At each sitting the foot is restrapped, without

FIG. 9-A

FIG. 9-B

December 24, 1940. R. M., aged three weeks. Anterior and posterior views before treatment.

FIG. 9-C

December 3, 1941. R. M. Photograph demonstrates the normal degree of overcorrection.

FIG. 10-A FIG. 10-B

April 16, 1941. A. P., aged four weeks. Anterior and posterior views before treatment.

any manipulation whatsoever being done. Soft-backed adhesive tape is used, and the selection of suitable widths is most important, especially for those passing across the front of the ankle (Figs. 5, 6, and 7). The position of the foot piece on the cross bar is then adjusted so as to increase the degree of abduction. If it is a case of unilateral club-foot, the normal foot is kept in an anteroposterior attitude.

It thus becomes evident that the adduction deformity is corrected by adjusting the splint each week into a further degree of abduction. The varus deformity starts its correction when the foot reaches the anteroposterior plane. In this position, when one leg is extended and the other flexed, the foot on the flexed side is forced into valgus. The equinus deformity reaches its maximum period of correction when the foot has been abducted to a right angle on the cross bar. When the child flexes the side with the abducted foot, it is forced into dorsiflexion. During an infant's waking moments, these movements with all their combinations are repeated hundreds of times. The degree and speed of correcting the varus and equinus can be increased by bending the cross bar away from the child (Fig. 4).

The foot is usually completely overcorrected at the end of six to seven weeks. During the second phase the splinting is continued in a position just short of full correction (right angle) until the foot is a reasonable size. This is usually at six to seven months of age.

At no time has any skin irritation or ulceration prevented the continuance of treatment. Anointing the feet with ether or tincture of benzoin compound has been helpful in some cases. Any other type of care —such as washing or rubbing off the epithelial debris—is discouraged. The author has been warned of the possibility of a knock knee but has not seen it occur yet. A cross bar suitable in length for the various age periods has probably prevented this complication.

The third phase of treatment begins at six to seven months of age, when the feet are measured for boot splints (Figs. 2 and 3) which have exactly the same fittings on the sole for adjustment with the cross bar. The boots are open at the toes to allow for growth, and fitted with an ankle strap which ensures the firm position of the heel on the sole.

The parent is then instructed in its use and also in the daily stretching of the foot. The splint is kept on day and night with the foot just short of a right angle. At about one year of age walking lessons are started for short periods each day.

FIG. 10-C

November 26, 1941. A. P. Photograph demonstrates how easily and normally full overcorrection is obtained.

In this fourth phase walking boots are supplied (Fig. 8), which have an outside wedge of three-sixteenths of an inch, and no heel. In this way the heel is kept low and the tendo achillis out to length.

The author is convinced that most of the recurrences are primarily due to a shortening of the tendo achillis, as a result of which the foot takes on an adduction and varus deformity in order to let the heel reach the ground.

The boot splint is now used as a night splint for at least another year.

This method has completely eliminated manipulations, plasters, tenotomies, and anaesthetics. Only half as much time at the Clinic is required.

Several recurrent cases (as a result of former methods of treatment) have been treated by the Denis Browne method with surprisingly good results. The degree of success, however, varies inversely with the age. In other words the older the child, the less is the tendency to struggle and

kick. An upper limit of three years of age is suggested for this method of treatment. The child should be encouraged to crawl, stand, and jump, so as to make up for the ceaseless kicking of the infant.

The author's experience has been rather limited with this method, but he is impressed with the remarkably normal appearance of these feet, the well-developed calves, and the absence of any tibial torsion. During the next few years it will be interesting to see if recurrences appear, as upon that will depend the success of this type of treatment.

The author wishes to thank D. E. Robertson, M.D., and the Surgical Staff for giving him the monopoly of these cases and allowing him to conduct the Clinic.

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# THE LUMBOSACRAL REGION

## A Correlation of the Roentgenographic and Anatomical Observations

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Present-day evidence suggests that the form and number of segments of the human spine are not constant, and that there is an evolutionary trend toward a reduction in the number of thoracolumbar segments and increased stability at the lumbosacral junction. The same factors which are thought to have been instrumental in effecting a reduction in the thoracolumbar segments of certain primates to seventeen or sixteen from the mammalian average of nineteen to twenty segments, are active at this time in man. These factors are: (1) a necessity for increasing vertebral stability brought about by an orthograde position, and (2) the influence of increasing body bulk on the length of the lumbar spine. These factors are interrelated, and their effect is shown by a continued reduction in the number of thoracolumbar segments in those anthropoids in which increased body bulk is combined with the upright posture. Keith[1] describes this shortening of the loin as not only effecting a great economy of muscular effort in the maintenance of the upright position, but also as eliminating some of the dragging strain on the viscera, which a longer loin in the upright position would entail.

### CLASSIFICATION

The vertebrae are classified into five groups—cervical, thoracic, lumbar, sacral, and coccygeal—on the basis of certain criteria which include: (1) the plane of the articular processes, (2) the development of accessory transverse processes, (3) the attachments of the ribs, and (4) the shape of the vertebral body.

Because of the aforementioned evolutionary trend, variations in the form and number of segments in each group occur in different individuals.

Variations in form are likely to be found in those segments of one group which are situated adjacent to another. One segment, therefore, may have some characteristics of one group and others of another, with the result that it may be difficult to determine to which group the segment belongs. Such a transitional segment is usually classified on the basis of its predominating characteristics. At the lumbosacral junction, variation in the plane of the articular processes from a sagittal to a coronal direction, together with enlargement ("fish-tailing") of the transverse processes, suggests that such a vertebra has assumed sacral characteristics and should be identified as a transitional sacral vertebra

A change in the number of segments in two groups may occur without altering the total number of segments in the whole spine; the addition of one segment to a group usually occurs at the expense of the adjacent group. The lowest lumbar segment, for example, may be so altered in form that it must be classed as sacral, leaving only four instead of five lumbar elements. Hence one may properly speak of the sacralization, partial or complete, of the lowest lumbar segment.

## COMBINED ROENTGENOGRAPHIC AND ANATOMICAL STUDY

The exact anatomical form of the various elements of the lower lumbar spine and the adjacent upper sacral segments is frequently difficult to appreciate from the roentgenographic examination, even with good stereoscopic, anteroposterior, and lateral views. This difficulty led the authors to undertake a combined roentgenographic and anatomical study of the lumbosacral region, with the hope of acquiring a better understanding of certain confusing lines and superimposed shadows on the roentgenograms.

During the past three years anteroposterior, stereoscopic, and lateral projection roentgenograms have been made of the lumbosacral spines of the fresh cadavera received by the Department of Anatomy. These roentgenograms were made before any radio-opaque material had been injected into the vascular system. One hundred and seventy-one cadavera were examined.

The source of material made the average age high, fifty-five and nine-tenths years, and resulted in a preponderance of males. In all cases where interesting anomalies or questions of interpretation arose in the roentgenographic examination, the lumbar vertebrae, sacrum, and ilia were removed, cleaned, and mounted, so that they could be carefully compared with the roentgenograms. Forty-two specimens in all were thus prepared.

The purpose of this paper is to present the results of this correlation of shadows on the roentgenogram with the actual anatomical arrangement and form of the segments in the dried specimen.

It was considered of value to make observations on the following points, the details of which are discussed in the text:

1. Architectural variations.
   (a) In the plane of the lumbar articulations;
   (b) In the transverse processes of the last lumbar vertebra;
   (c) In the fifth lumbar segment as a unit.
2. Incidence of congenital anomalies.
   (a) Bifid neural arch;
   (b) Separate neural arches;
   (c) Separate ossicles.
3. An estimation of the degree of osteo-arthritis shown in the roentgenogram for a comparison later with the actual amount present in the dried specimen. A correlation could then be made with the incidence of

variations in the plane of the articular facets as well as with the sacral inclination.

### ASYMMETRICAL ARTICULATIONS

The tendency in man for the lumbosacral articulations to lie most frequently in an oblique or coronal plane would indicate that stability, rather than flexibility, is the deciding factor in the position they assume. In man, flexion and extension of the lumbar vertebrae do not have the same functional significance which they do in quadrupeds. Variations in these articulations occur because the vertebral form of man is not stable and because there is a continued evolutionary influence, reflected particularly in variations of configuration in the last lumbar vertebra. Asymmetry in the plane of the facet surfaces is seen in the anthropoids, but is more frequent in man. Because of man's constant upright posture and forwardly inclined sacrum, structural variations at the lumbosacral joint are of particular significance, since this may result in alteration of

FIG. 1

Roentgenogram with arrow indicating an area suggesting a fusion failure.

weight transmission at the critical junction of an immobile and mobile spinal segment. The lumbosacral facets in quadrupeds most commonly lie in a sagittal plane. Evolutionary evidence indicates that in man the tendency is for these facets to assume a coronal plane, but for mechanical reasons it would be ideal if the lumbosacral facets were placed in a symmetrical oblique plane, since this compromise combines great stability with considerable agility.

It was found, in prepared specimens of the lumbosacral region, that facets (which on roentgenograms appeared to be oblique) were actually curved. As a matter of fact, no facet plane is purely oblique, sagittal, or coronal, but all have some curved component, corresponding to a segment of a cylinder, either completely or in part. These facets may appear on the roentgenograms as sagittal or coronal, depending upon which component is predominant. A pure form of one or the other is almost never found.

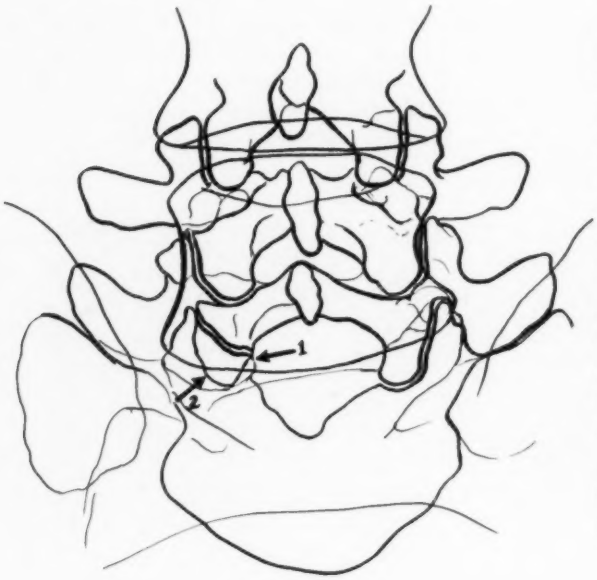


FIG. 2

Diagram of the roentgenographic findings.

*1:* The ventral margin of the sacral articular facet.
*2:* The inferior margin of the lumbar articular facet.

Variations in the plane of the posterior lumbosacral articulations are frequently difficult to detect even with stereoscopic and oblique projection roentgenograms. Figure 1 shows an example of a roentgenogram in which these articulations appear grossly asymmetrical. A comparison of these roentgenograms with photographs of the specimens (Fig. 3) and drawings of the region (Fig. 2) should indicate the reason for possible errors in diagnosis. Slight variation in the plane of the roentgen-ray projection would cause a sagittal portion of one articulation to stand out in relief, and obscure the plane of the articulation on the opposite side. Sacral inclination is also an important and confusing factor, for the lamina and articular processes of the last lumbar vertebra may consequently appear to lie almost in a coronal direction, "end on", and the margin of the lamina and the superior margin of the sacral articulation on one or both sides may form two slightly separated lines of increased density which closely resemble the roentgenographic ap-

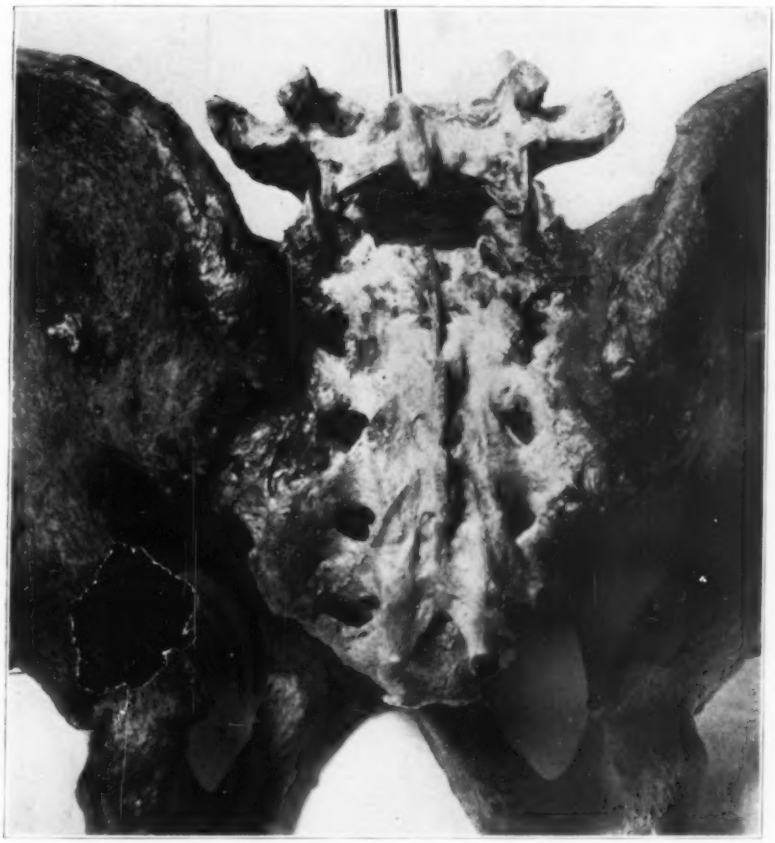

FIG. 3
Photograph of dried specimen showing no failure of fusion.

pearance of a defect in fusion of the neural arch or marked articular asymmetry.

Perhaps the best criterion for judging the probability of such a relationship between articular asymmetry and symptoms of pain is early evidence of degenerative arthritic changes at these joints. This is first indicated only by a narrowing and irregularity of the interarticular space and by increased density of the subarticular bone. Later a suggestion of osteo-arthritic lipping may be observed. This will be made evident by a sharpening of the normally rounded, smooth contour of the margins of the articular facets.

Asymmetry of the lumbosacral articulations may be noted in approximately one-quarter of all human spines. There are variations in degree of asymmetry, and the associated alterations in force transmission differ in significance. When the paired articular processes on one side approximate the sagittal plane, while those on the opposite side lie near a coronal plane, lumbosacral motion, as well as stresses, will be unequally divided

between the two. A coronally situated articulation can but inadequately share in flexion or extension, and with such motion the articular surfaces will be subject to trauma. The converse is true of sagittal articulations, which allow flexion and extension, but which would resist rotation and lateral motions. Asymmetry will further result in eccentric resistance to the shear stresses encountered at this point, since sagittal articulations are structurally ill-adapted for such functions. Not only weight transmission, therefore, but also spinal motions would be differently handled by asymmetrical articulations and under different conditions of activity; first one and then the other articulation would be the site of traumatic forces.

### ENLARGED, ARTICULATING, OR FUSED TRANSVERSE PROCESS OF THE LAST LUMBAR VERTEBRA

Unilateral or bilateral impingement of an enlarged transverse process of the last lumbar vertebra upon either the ilium or the sacrum is frequently seen with transitional vertebrae at the lumbosacral junction. Aside from actual impingement, the enlargement of the transverse processes of the last lumbar vertebra suggests that it has simulated to this extent the form of a sacral segment. In the authors' series this was noted in eighty-eight spines, or 51.5 per cent. of those examined. In twelve, or 7 per cent. of the total series, the enlargement was unilateral; in seventy-two, or 42 per cent., bilateral; and in four, or 2.3 per cent., asymmetrical. An additional eight spines, representing only 4.5 per cent., of the group studied, showed either impingement upon or fusion with the sacrum or the ilia. In three, or 1.7 per cent., this condition was unilateral, and in five, or 2.9 per cent., it was bilateral.

The fusion of enlarged transverse processes to the sacrum does not constitute a mechanical disability, and bilateral articulation of enlarged processes with the ilia or the sacrum will normally result in no asymmetry of weight transmission. Unilateral impingement without fusion, or bilateral and asymmetrical impingement and fusion will, on the other hand, result in altered spinal mechanics. This is because a lateral fulcrum has been created. The vertebral articulations then come to lie within arcs of circles of different diameters, each circle centering at the impinging, leverlike transverse process which now acts as an accessory fulcrum, altering motion and stress transmission at the lumbosacral joint. The articulations on the side opposite to the impinging process move through a larger arc of motion and correspondingly bear a major share of the transmitted stresses. Similar derangement of motion and stress transmission results between the lateral margins of the fifth lumbar body and the articular surface of the sacrum.

### VARIATIONS IN VERTEBRAL OSSIFICATION

Failure of fusion may theoretically take place wherever any two growth centers normally join, be they primary or secondary. The most

common of these are: (1) failure of fusion of the laminae, (2) failure of fusion of the laminae and pedicles, and (3) failure of fusion of the various apophyses which may remain as separate ossicles. These are of particular interest when they affect the last lumbar and first sacral segments, for here they frequently affect the stability of the spine. They assume additional importance in view of their occasional misinterpretation as fracture, and the consequent, not infrequent, medicolegal repercussions which ensue. Throughout the study of this series of 171 spines, particular attention was paid to the search for unfused neural arches, and separate ossicles about the articular processes. Of the former, only two examples were found, an incidence many times lower than that commonly reported. No cases of separate ossicles about the articular processes were seen. Bifid spinous processes were noted in seventeen sets of vertebrae, with a total of twenty-one of these anomalies, the highest incidence being at the first sacral segment (9.5 per cent.). Separate ossicles about the margins of the bodies of the vertebrae were seen in eight vertebrae.

### OSTEO-ARTHRITIS

Exclusive of an individual's occupation, it has been felt that osteo-arthritis of the lumbosacral vertebrae should bear a relationship to several anatomical factors. Variations in the inclination of the sacrum, for example, could conceivably influence osteophyte production about the lumbosacral joints. In general, the opposing surfaces of the vertebral bodies of man approximate a horizontal plane, but at the lumbosacral junction the plane of this articulation averages 45 degrees from the horizontal.* Shearing stresses, therefore, add to the forces that must be resisted at the lumbosacral joint. With a sacral inclination of 45 degrees, this force averages approximately 75 per cent. of the normal transmitted body weight at this junction. Decreased inclination will reduce these shearing forces, and conversely an increased inclination will increase them. Strain against the posterior articulations should be proportionately greater and might be expected to be reflected in a greater incidence of osteo-arthritis in those spines with increased sacral inclination, but an analysis of this series indicates that this does not invariably follow. There is such slight discrepancy between the comparable degrees of arthritic change in those spines with sacral inclinations of more than or less than 45 degrees, that no conclusion as to the effect of sacral inclination is warranted.

As noted above, the preponderance of the shear stresses at the lumbosacral joint are resisted by the posterior articulations. These, if they lie either in a coronal or oblique (curved) plane, strongly resist any tendency of the last lumbar vertebra to be displaced forward. Little resistance is offered by sagittal or asymmetrical articulations,—in fact,

* The authors recognize the many ways that have been used to measure the lumbosacral angle. They felt that measuring the degree of tilt of the upper surface of the sacrum to the horizontal was best for their purpose.

with the latter, irregular concentrations of stresses occur. A statistical analysis of the degree of so-called degenerative osteo-arthritis in relation to the plane of the lumbosacral articulations in the material bears this out. Lumbosacral articulations lying in a bilateral, symmetrical, coronal plane occurred in 22.5 per cent. and showed the lowest incidence of osteo-arthritis, as evidenced by an overgrowth of bone along the joint margins. Oblique (curved) articulations were noted in 44 per cent. and were second lowest in incidence of arthritis. Asymmetrical articulations showed the highest incidence of arthritic involvement, and were observed in one-quarter of the spines examined, whereas sagittal articulations, although showing a similarly high incidence of arthritic change, were found in only 8 per cent. of the spines of this series. It should be borne in mind that the average age of the patients in this series makes the incidence of degenerative arthritis rather high.

Further, all decisions regarding the degree of arthritic involvement of the vertebral joints should be influenced by the knowledge that the roentgenographic estimations of the severity of the degenerative process tend to err on the conservative side by between 50 and 75 per cent. Thus, when arthritis is unmistakable on the roentgenogram, the disease is already moderately advanced.

## SUMMARY AND CONCLUSIONS

An attempt has been made to correlate the roentgenographic and anatomical findings at the lumbosacral junction by careful comparison with dissected specimens. Besides the statistical data on the various anomalies which occur in this region, two findings were of interest. The first was that the degree of osteo-arthritis present in a given case is always a great deal more advanced than the roentgenograms would indicate, particularly as far as the posterior elements of the vertebral segments are concerned. The second was that there are confusing findings in the roentgenograms at times which, because of the varying projection of the central roentgen-ray beam and the asymmetrical development of the articular processes, will produce an appearance suggestive of failure of fusion, but in reality the segments will be found quite intact. The variations in the anatomical structure have been briefly discussed.

The oblique, coronal (curved) plane is perhaps the most desirable for the human lumbosacral articulations, and the approach to the coronal plane should be considered the "evolutionary normal".

1. Keith, Arthur: Man's Posture: Its Evolution and Disorders. British Med. J. I, 499, 1923.

# LOOSE BODY OF THE KNEE DERIVED FROM THE MENISCUS

BY EMIL D. W. HAUSER, M.D., F.A.C.S., CHICAGO, ILLINOIS

The derivation of loose bodies in the knee is not only of scientific value, but is also of definite practical interest. The scientific importance is the fact that a fragment of the meniscus, torn free so that it lies within the joint cavity, will, after a period of time, assume the characteristics of a joint mouse. The surfaces wear smooth, and the fragment gradually assumes a symmetrical shape. There is an alteration in the cartilage, so that the outer surface is laminated. The appearance of the loose fragment becomes identical with the appearance of a loose body which is derived from some other source,—such as one derived from the articular cartilage, as is the case in osteochondritis dissecans. It would appear from this, that a rough fragment of cartilage within the joint cavity is affected by the synovial fluid and the friction rub, so that it assumes typical characteristics, even though the original sources of the loose fragments may be variable.

The percentage of cure following operation for fracture of the meniscus varies from 80 to 90 per cent.[1] This leaves a definite number of cases which are not entirely relieved by surgery. In spite of the fact that this percentage is not large, it should be smaller. The author wishes to report four cases in which loose bodies were derived from the meniscus. It is evident that if the injured meniscus is removed without recognition and removal of the loose body, there will be a recurrence of symptoms.

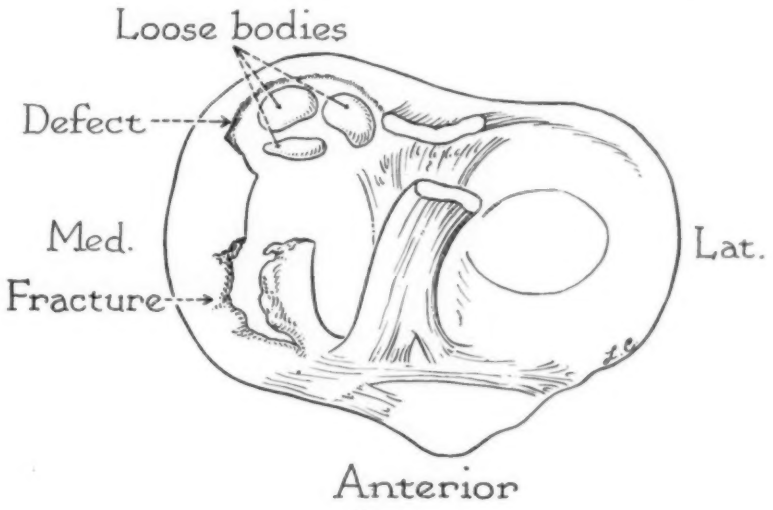


FIG. 1

Left knee. Defect in posterior aspect of meniscus and three loose bodies in posterior compartment.

CASE 1. A twenty-six-year-old medical student, ten years previously, had injured his knee at football. A diagnosis was made of an internal derangement of the left knee.

On June 21, 1934, surgical exposure revealed a thickened capsule, and an increase in joint fluid. A fracture was present in the anterior part of the cartilage (Fig. 1). The anterior half was easily removed. The posterior half was then removed and was found to be fragmented. Several small fragments about the size of half of a lima bean were seen floating in the joint fluid, and were removed. They were evidently derived from the meniscus, and the surfaces were worn smooth. The patient's recovery was uneventful, and he was allowed to go home on the fourteenth day.

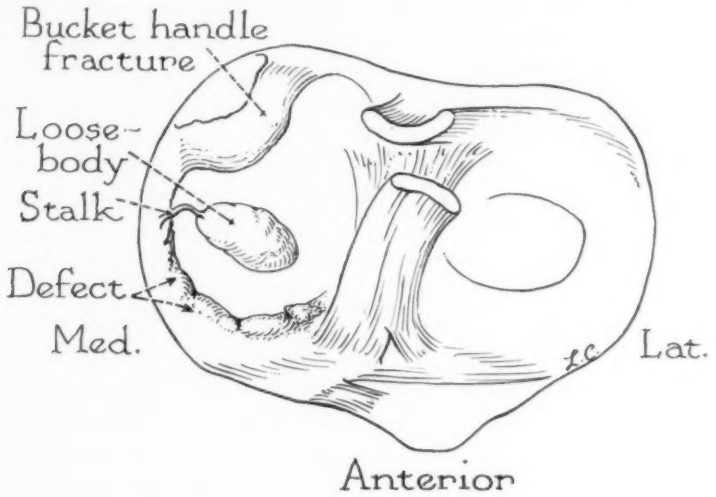


FIG. 2

Left knee. Loose body, except for small, stalk-like attachment, and the defect in meniscus from which it was derived.

In this case there were several loose bodies derived directly from the injured posterior part of the cartilage. They were still in the posterior compartment. Apparently the posterior part of the cartilage had been torn free and then was caught in between the joint, and these small fragments were gradually worn between the articular surfaces.

CASE 2. A thirty-nine-year-old man had slipped and injured his knee. He had had pain and swelling for two and one-half years. A diagnosis was made of traumatic arthritis with synovial changes and possible fracture of the medial meniscus.

On April 7, 1936, the joint cartilage was exposed and a loose body, one and two-tenths centimeters in width and two and four-tenths centimeters in length, was found in the joint cavity (Fig. 2). It was attached by a threadlike membrane to the medial meniscus. The anterior part of the medial meniscus had been torn free from its attachment. This portion of the cartilage and the loose body were removed. The incision of the capsule was elongated, the tissue retracted, and with further dissection a bucket-handle type of fracture of the posterior part of the meniscus was exposed. The entire meniscus was removed. The postoperative course was uneventful; after six weeks the patient was dismissed, and he has remained well.

This case shows the defect in the cartilage; the fragment that was torn free was attached by a very fine stock. This fragment had worn

smooth and assumed all of the characteristics typical of a joint mouse. In this way it gave evidence of the formation of a loose body derived from the meniscus.

CASE 3. A thirteen-year-old boy, three years previously, had injured his knee while jumping. He had had repeated attacks of locking. The loose body was palpable, but not demonstrable by roentgenograms.

At the time of operation, May 1, 1936, the loose body was identified and removed (Fig. 3). The knee was examined to establish where the loose body came from, and osteochondritis dissecans was ruled out. In the central half of the meniscus there was a crescent-shaped defect. The shape of the loose body showed that it was derived from this defect. The anterior part of the lateral cartilage was torn free from its attachment and there were tags extending into the knee joint. The entire meniscus was removed. The loose cartilage had been worn smooth and assumed the characteristics of an ordinary joint mouse, with the exception that its shape was a little unusual. The patient made an uneventful recovery, and he has had no trouble since.

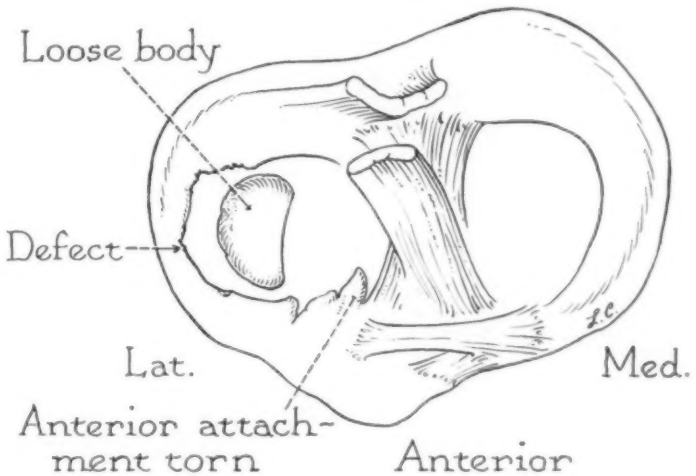


FIG. 3

Right knee. Loose body corresponding to defect in lateral meniscus.

The diagnosis in this case was a fracture of the lateral meniscus with a fragment torn free, which gradually assumed the characteristics of a joint mouse.

CASE 4. A forty-one-year-old man had injured his knee playing badminton four and one-half months previously. He had a history of knee-locking, which was not entirely relieved after manipulation. A diagnosis was made of an internal derangement of the knee, and an open operation was advised.

On October 22, 1940, a small incision was made on the medial side. The synovial membrane was thickened, and there was an increase in the synovial fluid, which was thicker than normal and had a yellowish tinge. The prepatellar fat pad showed an increase in size and a thickening of the tissue. The anterior part of the cartilage seemed loose. The cartilage was removed, but there was not sufficient change to explain the symptoms, so the wound was closed, and an incision was made on the lateral side. The anterior part of the cartilage was intact, but there was a fracture with a free end at the middle third (Fig. 4). The entire middle part of the cartilage had been torn free and

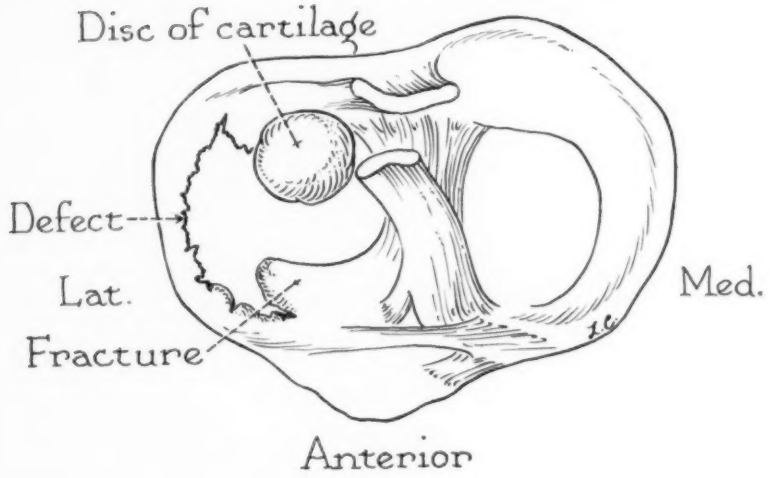


FIG. 4

Right knee. Disc of cartilage in posterior compartment, derived from central part of meniscus.

was missing. The fragmentary margin was removed. In the posterior part there was a fragment that was intact and this was removed. Posteriorly and lying on the surface of the tibial cartilage was a thickened disc about the size of a nickel. This disc apparently caused the block in flexion. The disc was lifted by means of the end of a scissors, and the margin, still attached posteriorly, was dissected free by means of a special dissecting knife which has a cutting edge on the end. This disc was then removed and the knee could be flexed, as well as extended. The knee was then fully flexed and extended, and examined repeatedly to see if there were any further loose bodies present.

This case demonstrates an unusual condition in which there was a bucket-handle type of fracture of the meniscus which had torn free at its anterior end. Apparently, in the course of the manipulation, the bucket-handle portion had been forced posteriorly and had been caught between the articular surfaces, where it had been gradually ground smooth on both sides and worn thin at the edge to form a disclike body. Although this body was still attached at the posterior margin of the cartilage, it acted as a loose body to interfere with movement at the knee joint.

These four cases show the presence of loose bodies in the knee joint caused by injury of the meniscus. A fragment, torn free, migrated into the joint cavity, where bathing in joint fluid and the action of the articular surfaces gradually altered the fragment until it was smooth and symmetrical, and assumed the appearance characteristic of a joint mouse. The clinical significance of a loose cartilage is that it must be found and removed; otherwise symptoms will continue, even though the injured meniscus has been satisfactorily removed. This in turn emphasizes the importance, in case of a fractured meniscus, of removing the entire meniscus and of accounting for all of the tissue.

1. FISHER, A. G. TIMBRELL: Internal Derangements of the Knee-Joint. Ed. 2, pp. 98–101. New York, Macmillan Co., 1933.

# EXCISION OF THE PATELLA

## Some Experimental and Anatomical Observations

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The widespread practice of a new surgical procedure has often served to focus attention on limitations in our knowledge of the structures concerned. This is certainly the case with regard to the patella. The vogue of patellar excision in cases of fracture has become very widespread, and the operation has also been recommended and used for sundry other disabilities of the knee joint, in consequence of the apparently innocuous nature of the procedure. It is probable that, as in most other operations, indications for it will eventually be established by a process of trial and error; but in the meantime, it seems that the success of the method has led to much conjecture and confusion with regard to certain aspects of the function, and even of the gross anatomy of this somewhat mysterious bone.

It appears to the authors that this is a suitable time to take stock, for in recent years, removal of the patella has been urged as a means of obtaining drainage in suppurative arthritis of the knee, and also as an easy and suitable alternative to displacement of the patella in major arthrotomy of the knee joint[12]. Underlying these recent applications of the operation is the impression that the method is easy and without harm. Indeed, Mader claims that it is an ideal step in arthrotomy because it gives rise to no disability and permits of a short convalescent period. The operation has also been carried out in recent years for osteo-arthritis of the knee joint, and for habitual subluxation of the patella, though reports of its success in these disabilities are less enthusiastic.

The authors became interested in the subject of the removal of the patella and its effects in 1936 when they were engaged upon some investigations concerning the growth of bone. It was their belief that, if the patella served any useful purpose—which they supposed it did—then it would regenerate after removal, or else be replaced, as is a meniscus of the knee joint, by a structure of similar size, or shape, or function.

Carey, Zeit, and McGrath in 1927 found that in young puppies the removal of the cartilaginous patella was followed by the development of a similar mass of cartilage, if free movement was permitted at the joint. They drew the conclusion, apparently justifiably, that the presence of certain mechanical conditions could determine the formation of a cartilaginous substitute from "indifferent" mesodermal or fibrous-tissue cells.

In 1933 Niven cultivated *in vitro* the mesenchyme destined to form the limb of the chicken embryo, and found that as the living culture grew, it differentiated, and a bony patella gradually appeared. This led her to conclude, again with every justification, that the primary development of the patella was the result of intrinsic and inherited factors, and was quite independent of mechanical considerations.

These two observations are not actually contradictory, for it may be quite true that the initial development of the patella is predetermined, whereas the loss of the original patella is followed by the development of a similar type of structure, provided certain mechanical conditions obtain.

Excision of the bone for fracture was advocated in 1937 by Brooke, and it was obvious that the early results of this method were of a strikingly high quality. As a result of his own experience Brooke was led to certain conclusions, and ceased to regard the patella as having any functional significance in the mechanics of the knee joint; he considered it merely a useless appendage.

In 1908, Murphy of Chicago reported several cases of removal of the patella for tuberculous osteitis. In this paper, he indicated that Putz of Strasbourg in 1860 had practised the method, and discovered, in consequence, that the patella was not essential for gait. To this view Murphy himself inclined, since in his own cases the function of the joint after operation was satisfactory. Moreover he went further, alleging that the theory, which held that the patella served to facilitate the sliding of the quadriceps tendon on the femur, and assisted the quadriceps in transmitting its action to the leg, was no longer tenable. In this particular point of view, he was in agreement with Joachimstal, who had encountered quite normal function in cases of congenital absence of the patella; the same observer, incidentally, showed that certain animals which used the quadriceps extensively had no patella. In Murphy's communication, there is one other reference of considerable interest in connection with the subject of this paper. Apparently it was common knowledge at the end of the last century that the patella could be reproduced if a "subaponeurotic" method of removal was employed. François, according to Murphy, had been the first to show that this was so; the substitute, he discovered, could be bony or cartilaginous; it was generally smaller, but "physiologically" it was the equivalent of the excised bone.

An interesting review of the whole subject of fracture of the patella was contributed by Heineck in 1909. He had been able to collect seventeen cases in which the patella had been removed during the preceding ten years, in ten of these cases because of fracture. The results in all these cases were rated good to excellent, but Rogers, Scudder, Le Boutillier, and Rouvillois drew attention to some consequent limitation of flexion. Heineck himself observed that under certain circumstances the patella was unnecessary for locomotion, but that its removal was invariably followed by impairment of power, and by some functional loss. Among the possible ill effects, he mentioned lack of protection to the knee joint,

disturbance of leverage, so far as the quadriceps is concerned, and loss of the usual pulley effect. Heineck's final judgment was to the effect that removal of the patella was quite unjustifiable in the case of uncomplicated fractures; his view received additional support from the experience of himself and others, that in fifty-three cases of congenital absence of the patella there was some functional incapacity of the knee joint.

Removal of the patella in chronic arthritis was first suggested by Ludloff in 1926. He claimed good results for the operation, and found it useful also in recurrent dislocation of the patella. Since its "modern" reintroduction, the method has again been applied to these two conditions, with varying results, although Watson-Jones recommends it for osteoarthritis confined to the patellofemoral compartment of the joint.

The value both of total, and even of partial removal of the patella in cases of recent fractures was also stressed by Blodgett and Fairchild in 1936. Apart from Murphy who quotes François as his authority, these are the only authors to raise the question of possible regeneration of the patella after resection. In several of their cases, scattered areas of new bone formation were demonstrated roentgenographically at the site of the operation.

It is apparent that there is well-authenticated evidence that removal of the patella does not grossly disturb the function of the knee joint. In fact, in Brooke's experience, the very opposite obtains, and the movement of the joint and the strength of the quadriceps is actually increased after the operation. Brooke used these findings to support the view of De Vriese that, since the infant's patella is relatively much larger than that of the adult, the bone is in the process of phylogenetic reduction, and has no functional significance. Furthermore, since the activity of the quadriceps appeared to be enhanced by removal of the patella, it was concluded that a functional association between the two structures was non-existent, and it was a short step from this to postulate an actual anatomical dissociation. According to Brooke—and the assertion is supported by his illustration—the patella is not at all in anatomical connection with the quadriceps, but is entirely separate from it, and lies actually behind the tendon in a loose fatty tissue, the presence of which renders the enucleation of the bone a procedure of great simplicity.

This work of Brooke's received the distinguished support of Hey Groves who examined two specimens of the knee joint prepared for him by Whitnall. These convinced him that the patella and the quadriceps have only a very loose relationship the one to the other, neither the upper nor the lower margin of the patella affording direct attachment to quadriceps fibers. These views did not conform to those which the present authors had arrived at from observations of a limited amount of material prior to the publication of these papers. Since then, they have extended the scope of their investigations, and it seems to them that the time is now ripe for a review of the fundamental points at issue. These are:

1. The exact relation of the quadriceps tendon to the patella.
2. The effects and sequelae of removal of the patella.
3. The functional significance of the patella.

The first of these problems has been examined in the light of the development and the adult anatomy of the bone; the second by experimental means; while the third is, to the authors' minds, clarified by a consideration of the other findings.

FIG. 1

Photomicrograph of the knee region of a 20-millimeter embryo showing condensation of cells in the quadriceps tendon at the site of the future patella.

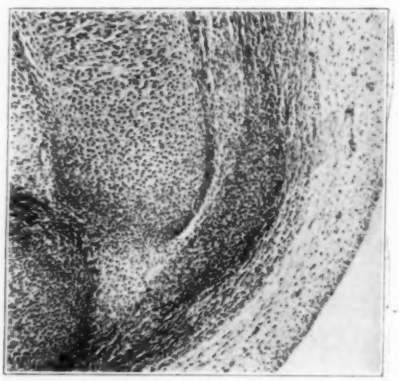

FIG. 2

Photomicrograph of the knee of a 23.4-millimeter embryo. The patellar anlage is now quite obvious.

The point at issue is not whether removal is better than suture in the case of fracture, but whether the good results which attend the operation have led to looseness and inaccuracy with regard to the importance and the anatomy of the bone, and whether enthusiasm for a new method has led to its employment in unsuitable circumstances, and despite possible ill effects.

## THE DEVELOPMENT OF THE PATELLA

The complicated structure of the knee joint has stimulated much research on the subject of its development. The patella has usually been regarded as the largest of the sesamoid bones, developed and, in adults, situated in the tendon of the quadriceps femoris, but this is the view which has been challenged by the observations of Brooke and Hey Groves.

A large series of human specimens have therefore been investigated. They were prepared especially for a study of the development of the knee joint, and all the smaller specimens (up to sixty millimeters crown-rump length) were cut serially, one knee joint of each specimen being cut in the sagittal plane, and the other in the coronal plane. In the larger specimens, sections were taken at different levels throughout the joint, and numerous dissections were also made. Dissections and sections of adult knee joints have also been studied.

The mesenchymatous anlage of the quadriceps femoris is present in

the twenty-millimeter human foetus, and the continuity of its tendon with the perichondrium of the tibia is clearly established (Fig. 1). Although there is, as yet, no definite precartilaginous patella, there is a slight relative increase in the cellular content of that part of the quadriceps tendon which lies in front of the lower end of the femur. This portion of the tendon undergoes a rapid change in successively older foetuses, and in the twenty-four-millimeter foetus there is a well-defined precartilaginous patella. The patella of a foetus twenty-three and four-tenths millimeters long (Fig. 2) is represented by an aggregation of rounded and oval cells at the upper and lower ends of which there is a transition zone, where the cells undergo a gradual change in form. There is no sharp line of demarcation between the patella and the tissues of the quadriceps above and below it. Between the patellar anlage and the femur there is loose mesenchymatous tissue which is continued upward as far as the origin of the vasti. Below, it is continuous with the mesenchymatous tissue of the joint plate. On the medial and lateral sides, this tissue blends with the expansions from the vasti, so that there is no evidence of a synovial cavity. The smallest foetus in which a cartilaginous nucleus has been observed in the patella is a thirty-millimeter foetus. In this foetus the cartilaginous patella lies in the deep part of the quadriceps tendon in front of the distal end of the femur. From this stage onward the cartilaginous patella grows rapidly and even

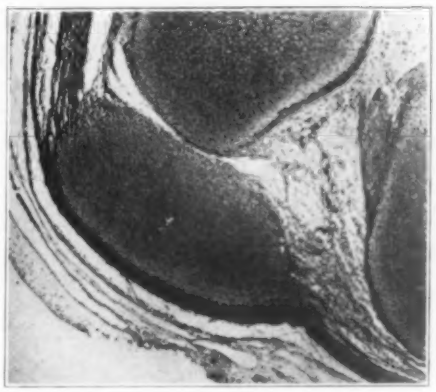

FIG. 3

Photomicrograph of knee of 40-millimeter embryo. The patella is now well formed, and there is a definite joint space between the femur and the patella. The strata of the quadriceps are well marked.

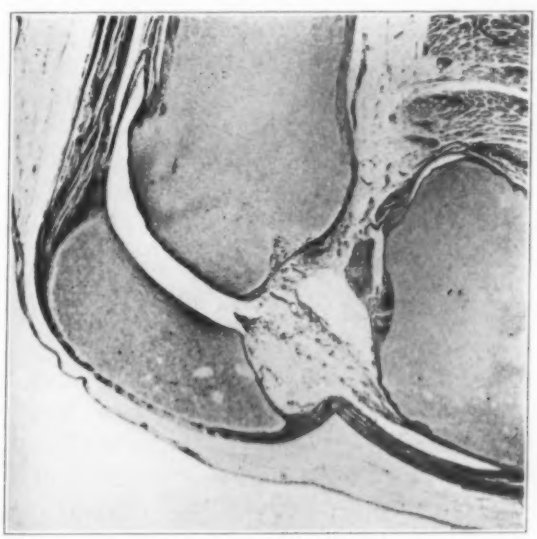

FIG. 4

Photomicrograph of the knee of a 90-millimeter embryo. The patellofemoral synovial cavity is now complete. The patella is relatively great in size in contrast with the lower end of the femur. It is still closely associated with the quadriceps tendon.

FIG. 5

Photograph of a sagittal section of the knee joint of a full-time foetus to show the form and relative size of the patella at birth.

by the thirty-two-millimeter stage it is a well-defined structure lying within the tendon. Up to this stage there is no synovial cavity in the knee joint, and the patella is separated from the femur by loose mesenchyme which undergoes condensation in successively older stages until in the thirty-five-millimeter foetus there is a zone of closely aggregated cells between the cartilaginous patella and the femur. During the next five millimeters of growth this zone becomes relatively thinner, so as to form a disc of cells which is exactly similar to the primitive joint plate of the simple diarthrodial joint. In one of the forty-millimeter specimens which were examined, the joint plate had already commenced to break down at its periphery, and this constituted the first sign of the retropatellar part of the synovial cavity (Fig. 3). The quadriceps at this stage is well developed, and descends toward the patella in three strata. The *superficial stratum* is the thinnest and becomes separated from the main muscle mass about seventy micra above the patella. It extends downward in front, is quite independent of the patella, and breaks up into a series of fine processes which ramify in the loose subcutaneous tissue in front of the lower part of the ligamentum patellae. As this lamina passes downward it loses the dark-staining reaction of the muscle fibers, and near its termination becomes very vascular. The *intermediate stratum* becomes thinner as it descends, and passing towards the anterior surface of the patella becomes continuous with the fibrous lamina that lies in front of the cartilage. The *deep stratum* retains its muscular characteristics as far as its attachment to the upper border of the patella, where there is a gradual transition between its cells and those of the cartilage. The ligamentum patellae is formed in part by the continuation downward of the fibrous stratum that is on the front of the patella, and in part by fibers which arise from the lower border of the patella. The tendon descends to the front of the upper part of the tibia where it blends with the perichondrium; the perichondrium is much thicker below the attachment of the tendon than it is above it.

From the forty-millimeter stage onward the quadriceps retains the relationship to the patella which has just been described. The synovial cavity increases in size by the breaking down of the joint plate between the patella and the femur, and it also extends beyond the periphery of the patella, especially above it (Fig. 4). The patella increases in relative size until about the sixth month of foetal life, when it commences to un-

dergo a slight, but definite, relative diminution; its form and size at birth are shown in Figure 5. During the first few years of life the bone is still relatively large, and, according to De Vriese, does not assume its adult proportions until about the fifteenth year.

### THE RELATIONSHIP OF THE PATELLA TO THE QUADRICEPS FEMORIS IN THE ADULT

A review of the development leaves no doubt as to the close relationship between the patella and the quadriceps in the developing embryo. These findings, however, are in sharp contrast to the opinions of Brooke and Hey Groves, and the authors decided to pursue the investigations in the adult as well. This was done both by dissection and sagittal sections in adult cadavera.

A short distance above the patella the quadriceps muscle has three strata (Fig. 6). The superficial stratum is formed by the rectus femoris, the middle by the vastus medialis and vastus lateralis, and the deep stratum by the vastus intermedius.

FIG. 6

Section through the quadriceps and patella of an adult. The quadriceps strata are distinctly shown and the attachment of the fibers to the upper border of the patella is obvious.

An aponeurosis of insertion is present on the deep surface, and along the anterior border of the lower half of the vastus lateralis, about three centimeters above the patella, it fuses with the adjacent part of the aponeurosis of the vastus medialis, which appears near the lower end of the muscle. The combined aponeurosis of the two muscles is in the form of a series of laminae which descend to be attached to the upper border of the patella, the one behind the other. The remaining parts of the vastus lateralis and vastus medialis are inserted partly into the rectus tendon, but chiefly into the lateral and medial borders of the patella, and also, by aponeurotic expansions—the retinacula—into the condyles of the tibia. The muscle fibers of the vastus medialis, as is well known, extend farther downward than those of the lateralis.

The lower part of the vastus intermedius is covered by the combined aponeurosis of the vastus lateralis and vastus medialis, and, although it is adherent to this aponeurosis, there is no interchange of fibers, and the

two strata can be separated from each other. The tendon of the vastus intermedius is inserted independently into the upper border of the patella behind the vastus lateralis and vastus medialis. The *superficial* part of the quadriceps tendon consists in the main of the rectus femoris, but it has contributions also from the superficial parts of the vastus lateralis and vastus medialis. About five centimeters above the patella the tendon of the rectus widens into a thin broad aponeurosis which receives fibers of the vasti, and descends in front and on each side of the patella. Immediately above the patella the rectus aponeurosis is firmly attached to the aponeuroses of the vastus lateralis and vastus medialis, but the two strata can be defined accurately by sharp dissection. The rectus, moreover, is firmly attached to the upper part of the front of the patella, but it usually can be easily stripped from the lower part of the front of the bone. On each side of the patella, the rectus expansion blends with the deep fascia—being especially intimately related to the iliotibial tract on its lateral side—and is attached with it to the condyles of the tibia.

FIG. 7

Roentgenogram of the knee four weeks after removal of the patella. The patellar surface of the femur shows early erosion.

The main part of the ligamentum patellae is formed by fibers which are attached above to the lower part of the patella, but its superficial fibers are the downward continuation of the rectus femoris. The ligamentum patellae is inserted into the upper part of the tuberosity of the tibia.

## THE PRESENT EXPERIMENTAL OBSERVATIONS

Removal of the patella was carried out in a series of fourteen rabbits. The operative techniques employed varied slightly, but were based upon the procedures used in clinical practice. An anterior mid-line incision was the standard approach, and the resection of the bone was variously accomplished. In the majority, the patella and the aponeurosis covering it, together with the patellar retinacula, were divided transversely, and each half of the bone was then enucleated subaponeurotically. To effect this, it was necessary to divide the synovial attachments to the margins of the patella, and also to detach by sharp dissection the quadriceps fibers inserted into its proximal edge.

In a few cases the bone was removed unbroken after simple division of the aponeurosis, and, in several, the bone was removed entirely by cutting it out of the quadriceps tendon along with its covering aponeurosis.

The gap in the quadriceps and the capsule was closed in all save one case by a transverse line of sutures, generally of catgut; though in one or two rabbits, linen thread was preferred. In one case only, the gap was

closed in the vertical axis. This case has been disregarded in the review. The transverse closure of the gap tended to ensure the continued activity of the quadriceps fibers formerly attached to the patella, and implied that the suture line was being exposed to the stimulus of quadriceps contraction.

After operation, the animals were allowed complete freedom of activity. In order to encourage the free use of the limb, the rabbits were housed in a run equipped with a sandpit, and in all save one of the animals, the quadriceps resumed its normal functional activity. The electrical responses of the muscle were tested in each case, and found to be normal, and in each case, it was confirmed that the quadriceps was pulling through to its insertion in the tibia.

Roentgenographic examination of the hind limbs was carried out immediately after operation, to verify that no part of the bone had been left *in situ*. Thereafter, roentgenograms were taken at intervals of a month, and again at the time the animals were killed, which varied from seven days to twenty months after removal of the patella. After death, the macroscopic and microscopic changes in the knee were studied.

## EXPERIMENTAL FINDINGS

### 1. *Roentgenographic Changes in the Patellar Surface of the Femur and the Quadriceps Tendon*

Thirteen of the fourteen rabbits of the series showed changes in the patellar surface of the femur, and in some cases these changes were observed to begin as early as one month after the removal of the patella (Fig. 7). The rabbit, which did not show any roentgenographic change, had been killed seven days after the removal of the patella. The changes, as seen roentgenographically, were mainly localized to the lips of the patellar surface, one or both of which showed indentations and general irregularity (Fig. 8).

FIG. 8

Roentgenogram of knee twelve months after excision of the patella. There is well-marked erosion of the patellar surface of the femur. There is also some new bone formation in the quadriceps tendon.

In the quadriceps of the operated limbs of three of the rabbits (Nos. 1, 13, and 29), a small shadow appeared bearing approximately the same position relative to the joint as the patella. In rabbit No. 1, which was twelve weeks old at the time of the operation, the shadow was seen four weeks after the removal of the bone, and gradually increased in size during the succeeding months. Even after that time, however, the shadow was little more than half the length and less than half the thickness of the normal patella of the other limb.

In rabbit No. 13, which was six weeks old at the time of operation, the shadow did not

appear until the fifth month. It was then of a circular form with a diameter of two millimeters, and until the time of death, some fifteen months later, it showed no appreciable increase in size, though it became more dense.

The earliest change in rabbit No. 29, aged ten weeks at the time of operation, was only observed in the quadriceps eleven months after the removal of the patella. A small bony shadow was seen, but this shadow did not grow in size, and at the time of death, some two months later, was precisely the same as it was when first observed (Fig. 9). Nevertheless, close examination of the roentgenogram shows an obvious soft-tissue shadow surrounding the bony nucleus and having virtually the same size as the normal patella. On clinical examination, there was a mass in the quadriceps indistinguishable from the patella of the opposite side.

2. *Naked-Eye and Histological Observations*

After each rabbit had been killed both knee joints were isolated by dividing the femur about two centimeters above the joint, and the tibia and fibula about one centimeter below it. The normal knee joint was used in each case as a control and preserved in 10-per-cent. formalin. In five of the joints, on the side of operation, the quadriceps was detached from the femur and tibia, so that the articular surface of the femur and deep surface of the quadriceps tendon might be examined macroscopically. In each of them the naked-eye appearance and the consistency of the quadriceps were noted, and finally longitudinal sections were prepared. In the remaining nine rabbits, the knee joints were fixed in formalin, decalcified in 3-per-cent. nitric acid, and embedded in paraffin. A series of sagittal sections ten micra thick were then made through the appropriate part of the joint so as to demonstrate the microscopic changes in the patellar surface of the femur and the adjacent part of the quadriceps tendon.

FIG. 9

Roentgenogram of rabbit No. 29. There is a small bony nucleus, but an obvious soft-tissue mass, which corresponds to a firm mass embedded in the quadriceps.

In the interest of the experiments it was not desirable to interfere with the relationship of the quadriceps tendon to the femur in all of the limbs, but in five of them the quadriceps muscle was detached from the femur and the tibia, and a full exposure made

of the articular cartilage at the lower end of the femur. The macroscopic findings in these specimens confirmed what had been noted in the roentgenograms, and also showed the full extent of the changes. The five specimens all showed degeneration and ulceration of the articular cartilage of the patellar surface of the femur, with exposure of the subjacent bone. The striking feature of the process, however, was its constant localization to the patellar surface of the femur (Fig. 10).

The degenerative changes in the cartilage were confirmed by the microscopic sections which were made of the knee joints. In some places, the cartilage had completely disappeared, as well as the compact bone, so that the lamellae of the spongy bone and the intervening spaces were exposed. In many of the exposed bony lamellae there was a marked proliferation of the

FIG. 10-A

FIG. 10-B

Drawings of lower end of the femur to show the degenerative changes at the patellar surface of the femur.

bone corpuscles. These phenomena represent a particularly vicious form of chronic arthritis, and it may be concluded that in the rabbit this is the almost invariable sequel to removal of the patella.

The shadows which were observed roentgenographically in positions relatively similar to the resected patellae in rabbits Nos. 1, 13, and 29, have been confirmed, by microscopic examination, as bone. In each case the bony nodule lay in the substance of the quadriceps tendon at the level of the femoral condyles (Fig. 11). The bony nodules were, however, uniformly surrounded by quadriceps tissue as they lay in the superficial part of the tendon, and were separated from the femur by a part of it.

The bone of the largest of the nodules was relatively compact, but in the others it was less so, and the cavernous cavities were of an irregular

ovoid form. Immediately subjacent to the bone there was an irregular layer of cartilage, which gradually blended with the surrounding fibrous tissue. The part of the quadriceps, therefore, which articulated with the patellar surface of the femur had been converted into fibrocartilage.

In the other rabbits of the series,—that is, in those where no new bone growth was demonstrated roentgenographically, the patellar part of the quadriceps tendon was formed of fibrocartilage. The relative proportions of fibrous tissue and cartilage showed much variation in the different rabbits, but the cartilaginous element was relatively greatest in those animals which had been kept alive longest after the operation.

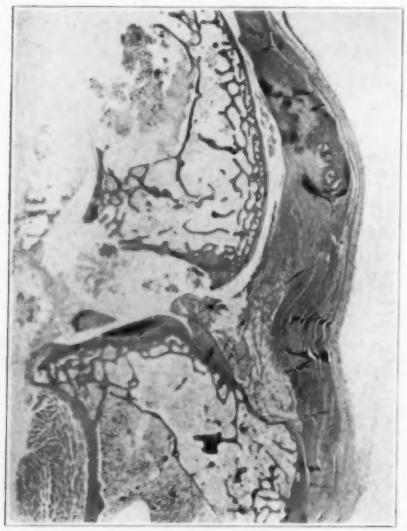

FIG. 11

Photomicrograph of a long section through knee joint. The presence of a bony nodule in the quadriceps is well shown.

## DISCUSSION

These studies of the development of the patella have shown beyond any doubt that the bone develops as an integral part of the quadriceps muscle, and the authors' observations on adult human material have further demonstrated that it remains an essential part of the extensor apparatus of the knee. This, of course, was the general conception, though it is now quite contrary to the views of Brooke, Hey Groves, and Watson-Jones. This difference of opinion does not, of course, affect the problem of the treatment of a fractured patella. When the bone is broken, it is not the fracture itself, but the damage to the extensor mechanism of the knee which is the significant feature of the injury, and repair is admittedly made easier by removal of the bone fragments.

It would be unfortunate, however, if clinical teaching were to become dissociated from the facts of anatomy, and it also would be difficult to explain certain well-recognized clinical phenomena and experiences in injuries about this region if it were assumed that the patella was quite separate from the quadriceps both in structure and in function.

Rupture of the quadriceps tendon affords some further support for the close association between patella and quadriceps. The lesion is an alternative one to fracture of the patella, but in striking contrast to the fracture, it is relatively infrequent. James assessed its occurrence as four to 318 by comparison with the bone lesion, and this in itself would be extraordinary if the muscle were not attached very strongly indeed to the bone. The muscle rupture occurs generally in men over middle age, and

the fact suggests that the tendon has previously been so weakened by degenerative changes that its resistance at the time of injury is less than that of the bone,—a state of affairs not generally obtaining. In a case of ruptured quadriceps in the care of one of us (J. B.), the operation revealed a fringe of strong fibers attached to the upper border of the patella, and direct suture was on this account possible and successful.

In view of the intimate place of the patella in the quadriceps apparatus, one naturally wonders how removal of the bone leaves as competent a knee joint as it appears to do. In the case of resection for fracture, this is not perhaps so surprising. In this injury, since the reconstitution of the extensor mechanism is the essential object of surgical treatment, the repair of the important part of this—the quadriceps tendon—is certainly facilitated by removal of the bone. Simple suture of the bone has also decided disadvantages. It can hardly be effected without the creation of a ridge or uneven area on its articular surface, and this leads in many cases to a local osteo-arthritis of the patellofemoral compartment of the knee joint.

The authors' experimental observations suggest, however, that osteo-arthritic changes are also to be anticipated following the removal of the bone. This is possibly unimportant in the case of fracture where the alternative method has the same effect and to an even greater degree. Nevertheless, it does suggest that removal of the patella should not be undertaken without proper indication,—certainly not for the purpose of securing access in the course of a so-called "wide" exposure of the joint. Its employment in osteo-arthritis is again open to question, since there appears to be at least some risk of aggravating, rather than relieving, the condition.

The occurrence of sharply localized degenerative changes in the articular cartilage after removal of the patella, suggests that, apart from, or in addition to, its other functions, the bone exercises at least a protective rôle so far as the patellar surface of the femur is concerned. It has generally been assumed that the patella formed a sort of pulley which maintained the tendon of the quadriceps in front of the axis of movement of the joint, and so increased its effectiveness. Gray states, "The patella is a great defence to the front of the knee joint; it also increases the leverage of the quadriceps". The evidence at the authors's disposal suggests that the protective function is the more important. Removal of the bone, for example, does not, to begin with, seriously if at all, affect the power of the joint movements, whereas the obvious changes in the articular cartilage indicate that fairly decisive harm results from its absence.

The likely cause of the damage to the femoral surface, after removal of the bone, is the friction of the quadriceps tendon, though the movement of the patella over the lower end of the femur during the act of flexion of the knee, and the relatively larger size of the bone in infancy, when kneeling is common and creeping the usual mode of progression, suggest that it may protect the articular surface from more direct external trauma. The

principal rôle of articular cartilage, with which the deep surface of the patella is of course clothed, is that of a cushion to absorb and dissipate pressure, and the cartilage of the patella is probably no exception to the rule.

The authors are satisfied, from their experiments, that, in the rabbit at least, there is an attempt at partial replacement of the patella following removal of the bone. The extent of this replacement varies greatly. Sometimes the new structure is bony, and at other times is composed of fibrocartilage. It seems that this is a further indication of its essential part in the joint economy. So far as is known, there has not been a detailed clinical or roentgenographic investigation on this point in the human subject, though one case of regeneration has now been reported by Mehriz. The authors have themselves encountered cases in which a very hard mobile discoid mass developed in the quadriceps tendon at intervals after resection of the patella for fracture. Roentgenographic examination was negative, and it was concluded that the disc was cartilaginous. The whole question requires further study, however, and the outbreak of hostilities prevented this part of the investigation being pursued to a definite conclusion.

## SUMMARY

1. The patella develops as a part of the quadriceps apparatus.

2. In the adult, it retains a close association with the muscle and with certain of the muscle fibers. Tendon fibers are directly attached to it.

3. It has to be separated from the muscle by sharp dissection which divides the muscular and tendinous insertions.

4. Removal of the patella in the rabbit is followed by degenerative changes in the articular cartilage of the patellar surface of the femur, but not by any apparent change in gait or in joint efficiency.

5. This suggests that the principal function of the patella is protective.

6. Removal of the patella is also followed by attempts at regeneration, which sometimes culminate in the development of a bony structure of appreciable size. In other cases, a fibrocartilaginous change takes place in the quadriceps tendon at the former site of the patella.

7. It is suggested that further investigation is necessary in the human subject, to determine the extent of the degenerative changes, before the operation is practised widely for conditions other than fracture or serious organic diseases of the bone itself.

The authors wish to express sincere thanks to their respective chiefs, Prof. Sir John Fraser, K.C.V.O., and Prof. J. C. Brash, for their help and advice in this study. The authors are also grateful to Miss Mann, C.S.M.M.G., for undertaking the unusual task of testing the electrical responses of the quadriceps in each rabbit. Mr. John Borthwick and Mr. D. B. Smith, the Technical Assistants in the two Departments, have afforded great assistance in the matter of illustrations.

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# STENOSING TENOVAGINITIS OF THE THUMB IN INFANTS *

BY ISADORE ZADEK, M.D., NEW YORK, N. Y.

The striking feature of this condition is its manifestation in a flexion deformity of the interphalangeal joint of the thumb. There is also some associated pain on attempted passive extension of the joint,—the patient being unable to extend it actively. In 1936, Jahss included reports of several of these patients in an article entitled "Trigger Finger in Children". The designation "trigger finger" implies a "snapping" which has not been present in patients whom the author has seen in infancy. There is no clear-cut history of injury to indicate a causal relationship.

In the usual type of tenovaginitis as seen in the hands of *adults*, two locations are common,—one is the short abductors and extensors of the thumb, and the other, one of the long flexor tendons of a finger or thumb. Both the sheath and the enclosed tendon are involved. The flexor tendon sometimes shows wartlike projections of granulation tissue attached to the tendon, and at other times a thickened sheath with an irregular inner surface surrounding the tendons.

When the involvement is in the abductor extensor group of the thumb at the styloid of the radius, the chief involvement is in the sheaths with a thin, pinkish, nebulous layer of tissue surrounding and attached to the tendons themselves. These patients do not show any snapping.

The snapping occurs when there is involvement of the flexor tendons with an incongruity between the surface of the tendon and the intimate surrounding sheath,—the snap being produced by the passing of the disproportionate thickened tendon through the narrowed sheath, so that it may occur on flexion or extension or both.

In the stenosing tenovaginitis in *infants*, the author has never seen a snapping thumb, though mechanically, it might be expected. The thumb presents a fixed deformity with the terminal phalanx flexed on the proximal phalanx at about 140 degrees. By the uninitiated, this is usually considered to be a dislocation. A thickening is felt on the flexor surface at the first metacarpophalangeal joint which gives the impression of a hypertrophied sesamoid. Pressure against this thickened area causes discomfort. When the thumb is forcibly extended passively, the skin over this thickened area becomes blanched and the flexor tendon distal to the swelling becomes taut. There is no difficulty in completely flexing the thumb, but further extension is limited.

Two cases in infants, showing an unusual development, are reported. At the time when operation was indicated because of the involvement of one thumb, examination showed that there was thickening over the volar surface of the first metacarpophalangeal joint of the opposite thumb, al-

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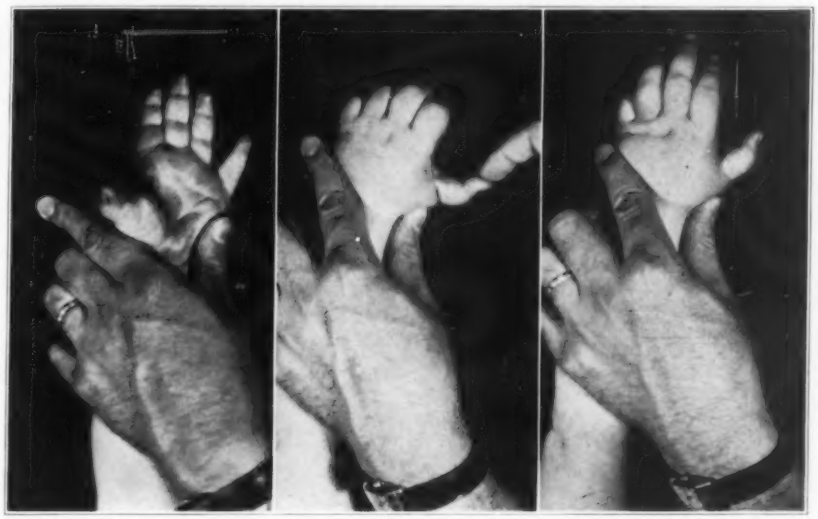

FIG. 1

Showing the fixed flexion deformity of the thumb.

most as prominent as on the side complained of, but there were no symptoms. A year later, the deformity and involvement of the opposite thumb was manifest in one patient; the other shows the swelling but is still almost symptomless.

## CASE HISTORIES

CASE 1. E. S., female, aged twenty-three months, was first seen September 18, 1939. Four weeks previously, she had injured her left thumb while playing under a table. Four hours later, it was swollen and bent. The child was taken to a hospital where the thumb was stretched, and a splint was applied; this was repeated several times under the mistaken diagnosis of a dislocation. The deformity of the thumb increased.

The thumb was found flexed at the interphalangeal joint to 125 degrees. It could be extended to 150 degrees. Flexion was not limited, but on further passive extension, the flexor pollicis longus was found to be quite taut from the first metacarpophalangeal joint distally. There was a swelling over the flexor surface of the first metacarpophalangeal joint which had the "feel" of a large sesamoid bone. It was somewhat movable and roughly the size of a bean. The skin over the swelling blanched under tension. No snapping was present.

She had a corresponding swelling affecting the right thumb, but there were no symptoms referable to this side.

The left thumb was operated upon on September 25, 1939; the sheath was split and a strip of sheath was removed from each side of the opening. The subcutaneous tissues were closed with plain catgut, and the skin with interrupted silk; a tongue-depressor splint was applied on the extensor surface of the thumb. The postoperative course was uneventful.

On May 21, 1941, examination showed a fixed deformity of the right thumb. The thumb was held flexed at 140 degrees. The right thumb was operated upon June 9, 1941. The postoperative course was uneventful, and she made a complete recovery.

Roentgenograms of both thumbs were negative prior to operation.

CASE 2. J. K., male, aged nineteen months, was first seen August 5, 1940, because of stiffness of the left thumb of a month's duration. There was no history of injury.

The thumb was held at 145 degrees, at the interphalangeal joint, and there was swelling over the flexor surface of the neck of the first metacarpal (Fig. 1).

There was a corresponding swelling on the flexor surface of the right thumb, but no symptoms have developed.

On June 10, 1941, the left thumb was operated upon through a transverse incision in the palmar crease. The postoperative course was uneventful, and he made a complete recovery.

The only treatment of value is operative. Splitting of the affected tendon sheath is all that is necessary, though the author removes a small segment in the longitudinal axis of the sheath for microscopic study. At operation, the constriction is found in the sheath of the flexor pollicis longus at the first metacarpophalangeal joint. The sheath is opened for a distance of one-half to three-quarters of an inch, and a probe or small grooved director is passed distally to the attachment of the tendon to the terminal phalanx and proximally for a corresponding distance, so that one may be sure that no constriction remains. The involvement may present itself simply as granulation tissue or it may be in the form of an encircling ring of fibrocartilaginous material. The tendon is found materially thickened proximal to the point of constriction. The involved area is best exposed through a transverse incision, following the crease on the flexor surface of the thumb, as this avoids any obvious scar. Only the subcutaneous tissues and the skin are closed,—the sheath itself being left open. A splint should be applied on the extensor surface of the thumb. Trauma probably plays little part in this condition in infants, and it is the author's opinion that the anomaly is of congenital origin.

## CONCLUSION

Stenosing tenovaginitis of the thumb in infants involves the flexor pollicis longus and presents itself as a fixed flexion deformity of the interphalangeal joint. Unless one is familiar with the condition, it may be considered a dislocation at the interphalangeal joint. The results of splitting the narrowed sheath are uniformly good and this is the only treatment of value.

# EXTENSION DEFORMITIES OF THE CERVICAL SPINE *

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The object of this paper is to show that extension deformities of the cervical spine and other remote factors can cause the symptoms found in the so-called scalenus syndrome and in cervical ribs; also, that the distribution of the symptoms will depend, among other factors, upon the location of the habitual position of extreme extension of the cervical spine. If the apex of the curve is in the upper cervical region, the distribution will be through the cervical nerve plexus; and, if in the lower cervical spine, the distribution will be through the brachial plexus (Figs. 1-A and 1-B).

Aynesworth describes the scalenus and cervical-rib syndrome in the inclusive term cervical-brachial syndrome and divides the cases into three groups: (1) those which exhibit neurological symptoms as their chief manifestation; (2) those which exhibit vascular symptoms as their major manifestation; and (3) those which exhibit a combination of vascular and neurological symptoms. This suggests the probability that there must be causes more widespread and remote than the usual explanation of local pressure from a thickened scalenus anterior or a cervical rib.

In about 80 per cent. of the cases the contributing cause of the symptoms has been judged to be trauma, combined with the many other pathological conditions confined to the area of the neck. These pathological conditions are due to abnormal function in a few anatomical structures,—the muscles in this region, the cervical vertebrae, cervical ribs, abnormal first ribs, the clavicle, the cervical nerve trunks, the subclavian artery and vein, and the sympathetic and vasomotor nerves.

To the writers, an extension deformity is a relatively fixed position of the joints, muscles, and ligaments, from which, if further motion is made increasing the deformity, strain or injury will occur. If the spine is in a position of full extension, further extension will cause injury, usually at the position of greatest extension or at some compensatory point. The amount of injury will depend on the anatomical structure of the injured part and its habitual position of use, combined with the habitual position of use and the anatomical structure of the rest of the body.

Only the anatomy of the cervical spine will be taken up, but an understanding of the anatomy of the rest of the body, both structural and functional, is equally important for a proper understanding of the whole picture. It is not necessary to describe in detail all the cervical vertebrae. There are certain points, however, that must be considered: (1) the bones, (2) the ligaments, (3) the muscles, (4) the nerves, and (5) the effect on these of faulty mechanical use.

* Read at the Annual Meeting of The American Orthopaedic Association, Toronto, Ontario, June 12, 1941.

FIG. 1-B



FIG. 1-A

Roentgenograms of cervical spine showing extension deformities in the upper and lower cervical regions. Such deformities are dependent on, or are compensatory to, deformities elsewhere in the spine.

FIG. 2

Roentgenogram of the cervical spine, showing variations in the relation of the body of the vertebra to the spinous processes. A line drawn parallel to the lower surface of the body of the vertebra is either at the level of the inferior border or crosses over the spinous process.

In a case of long-standing faulty body mechanics, a similar line will not only be above the spinous process, but may cross the spinous process of the first or second vertebra above (See Fig. 10-A). This makes a much more acute angle between the pedicles and the body, and narrows the space between the body and the vertebral arches, thus limiting the factor of safety that is normally present.

*Bones*

Variations occur in the shape of the vertebral bodies themselves. These may be congenital in origin or may develop from unusual stresses during the growing period. One of these variations is in the relation of the bodies of the vertebrae to their spinous processes. In some, a line drawn along the under surface of the body and extended backward just touches the inferior surface of, or crosses over, the spinous process (Fig. 2). In others a similar line will cross over the spinous process of the first or second vertebra above (Fig. 10-A). It has been found that this latter condition occurs in the presence of long-standing faulty body mechanics. Such a condition means a decrease in the angle between the vertebral body and the pedicles, and a consequent narrowing of the space in this region.

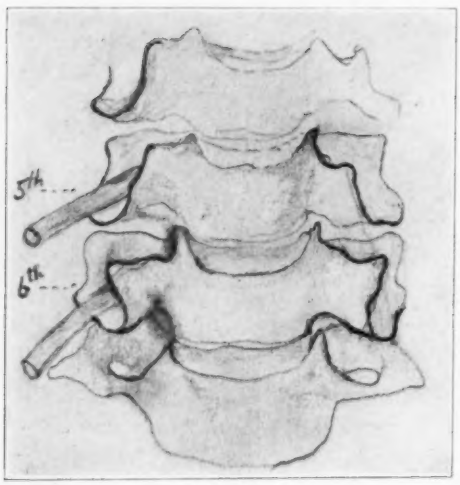


FIG. 3

Drawing of the cervical vertebrae showing the transverse processes and the grooves in which lie the nerves. Muscles and ligaments are also attached to the sides of the grooves.

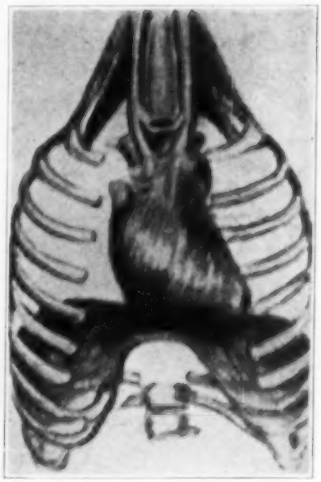

FIG. 4

Drawing showing the prolongations of the cervical fascia to the heart and diaphragm, as the suspensory ligament of the diaphragm. Note also the scaleni.

This increases the possibility of crowding the structures here, especially when combined with other abnormalities,—such as the result of hypertrophic arthritis, or of trauma.

*Intervertebral Foramina*

When the cervical spine is flexed forward, the size of the intervertebral foramina is greater than when it is at full extension. In full extension the articular facets of the vertebra below push up into the foramina, thus making them smaller. If there are hypertrophic or other inflammatory changes encroaching on the lumina, this position of extension will make the foramina smaller and there will be greater chance for irritation of the structures within the foramina,—that is, arteries, veins, and nerves.

*Transverse Processes*

The transverse processes of the cervical spine are so formed that they carry the nerve roots in a groove of varying depth, and thus protect them from possible injury as they emerge from the spinal canal and foramina of this freely movable part of the spine. This groove is like a U and the two free ends of the U represent the tubercles of the transverse processes. It is to these free ends of the U that many of the important muscles and ligaments are attached (Fig. 3).

*Ligaments*

Some of the ligaments which are attached to the tubercles of the transverse processes are the intertransverse ligaments and those which

connect the transverse processes to the vertebral bodies above and below. From the point of view of this paper, more important than these are the attachments of the deep cervical fascia to the tubercles. The deep cervical fascia is prolonged downward (Fig. 4) to spread over the muscles of the chest wall and the pericardium to the diaphragm. In faulty body mechanics the diaphragm is abnormally pulled downward by the weight of the abdominal organs and by the chest wall itself, thereby causing strain on all the structures in the neck. It is this abnormal pull of the weight of these structures on the neck that may explain some of the symptoms which are referred to the arm and the thorax, as well as the hypertrophies of the scaleni and tubercles.

*Muscles*

There are also attached to each free arm of the U the anterior and posterior tubercles of the transverse processes, the very important scaleni (Fig. 5). The scalenus anterior is attached to the anterior tubercles, and the large median and posterior scaleni to the posterior tubercles. The nerve roots come out between these muscles, as well as between the ligamentous attachments. The phrenic nerve, as it comes up from the diaphragm and thorax, becomes imbedded in the body of the scalenus medius before it joins the nerve root at the fourth or fifth cervical vertebra. These muscles, being inserted into the first and second ribs, are stretched and pulled downward in faulty body mechanics and in the associated extension deformity of the cervical spine, when the chest and diaphragm have drooped and sagged.

Other muscles which are attached to the tubercles of the transverse processes are the longus colli, the longus capitis, the multifidus and semispinales and the intertransversarii. The intertransversarii consist of seven pairs of small fleshy strips on each side, which connect the bifid extremities of the transverse processes. The anterior slip of each pair is attached to the anterior tubercles of two adjacent processes, while the posterior slips extend between the posterior tubercles. The highest pair of muscular slips lie between the atlas and the axis, and the lowest pair connect the seventh cervical vertebra to the transverse process of the first thoracic vertebra. The spinal nerves have a very definite relation to the intertransversarii. The anterior primary branches of the lower six cervical nerves pass outward between the two slips of the corresponding muscles. The posterior primary divisions of the same nerves turn backward behind the slips. All of these muscles can be affected by long-standing strains from extension deformity of the cervical spine and its associated faulty body mechanics.

*Ribs*

The normal first rib comes away from the spine at a slightly downward inclination, articulates with the transverse process, and continues around to the sternum with no distortion of the shaft in relation to the

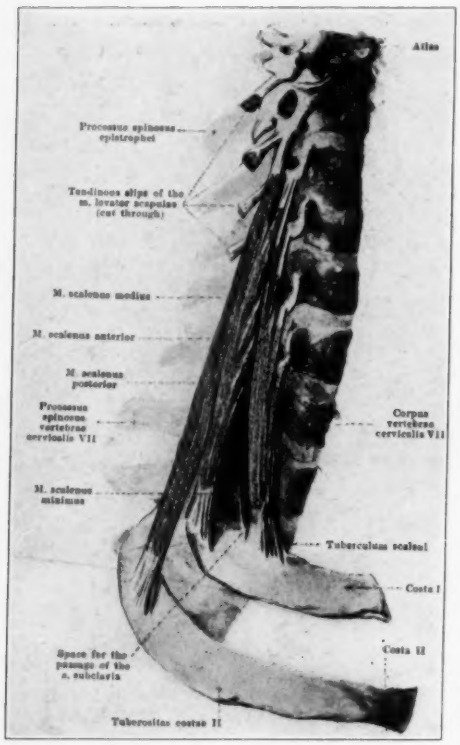


FIG. 5

Showing the origin of the scaleni from the tubercles of the transverse processes and their insertions into the first and second ribs. From this can be seen the possibilities of the combination of an extension deformity of the cervical spine and the downward pull of the chest and abdominal organs. (*Reproduced by courtesy of J. B. Lippincott and Company.*[2])

neck of the rib (Fig. 6-A). In faulty body mechanics the first rib, after it leaves the transverse process, is almost vertical to the ground, and the shaft rotates downward and forward, so that the shaft of the ribs is distorted in its relation to the neck. This can be seen in an anteroposterior roentgenogram (Fig. 7-B). In this position the sternum and the structures attached to it are closer to the front of the spine, and the chest as a whole has changed its shape (Fig. 6-B).

In faulty body mechanics of long standing, with the first rib rotated downward and forward, the sternum will be almost vertical instead of projecting obliquely forward (Fig. 8). This vertical position of the sternum and the drooped first rib mean a pull upon, and crowding of, the structures entering the thorax. With such a condition, it is easy to understand why, with advancing years and increasing faulty body mechanics, the potential of injury to the cervical and brachial plexus becomes greater. If there are present also abnormalities—such as long transverse processes of the seventh cervical vertebra, cervical ribs, abnormal first ribs and clavicles, abnormally large scaleni, abnormal brachial plexus, or abnormalities of the sympathetic nerves or subclavian arteries or veins—the possibility of symptoms is much greater, especially in the presence of strain or injury in this region.

The motions of the cervical spine, or injuries in this region, vary according to the habitual position of use. With the cervical spine in the best mechanical position for function, and with the curve not exaggerated, rotation takes place largely in the upper two cervical vertebrae. There is very little lateral motion here. In the lower vertebrae, the third to the seventh, there is very little rotation and much more lateral motion. However, when the cervical spine is in the position of extreme extension, as is present in habitual faulty body mechanics, all of these motions are much limited and in long-standing cases they will be accompanied by

FIG. 6-A

Good body mechanics. Note that the first rib comes away from the spine, articulates with the transverse process and continues around to the sternum at a slightly oblique angle, without distortion of the shaft in relation to the neck of the rib.

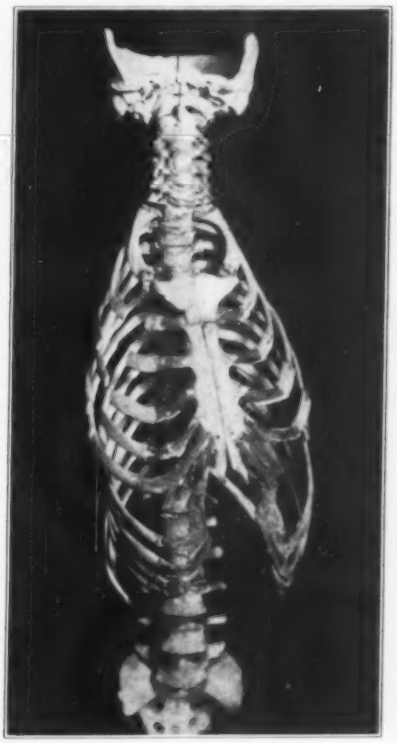

FIG. 6-B

Faulty body mechanics. After the first rib leaves the transverse process, the shaft rotates downward in its relation to the neck of this rib, and it is almost vertical to the ground.

considerable crepitation. This limitation of motion can be demonstrated by having the patient lie on his back and flatten the cervical curve before trying out the motions. If the motion is not increased, one must suspect anatomical or pathological changes in the joints.

## TREATMENT

The object of treatment is to correct the extension deformities in the cervical and lumbar regions of the spine, and also the flexion deformity of the thoracic spine and the associated drooped chest. The correction of the extension deformity of the cervical spine is most easily accomplished by recumbency on the back on a firm mattress. To relieve the strain on the lumbar spine, a large pillow under the knees and a small pillow to fill the hollow in the low back is helpful. With this procedure muscle spasm subsides quickly in most instances. The authors have rarely found head-traction necessary. A felt collar, fitted low in front and high in back, to reduce the extension deformity, adds to the patient's comfort

FIG. 7-A

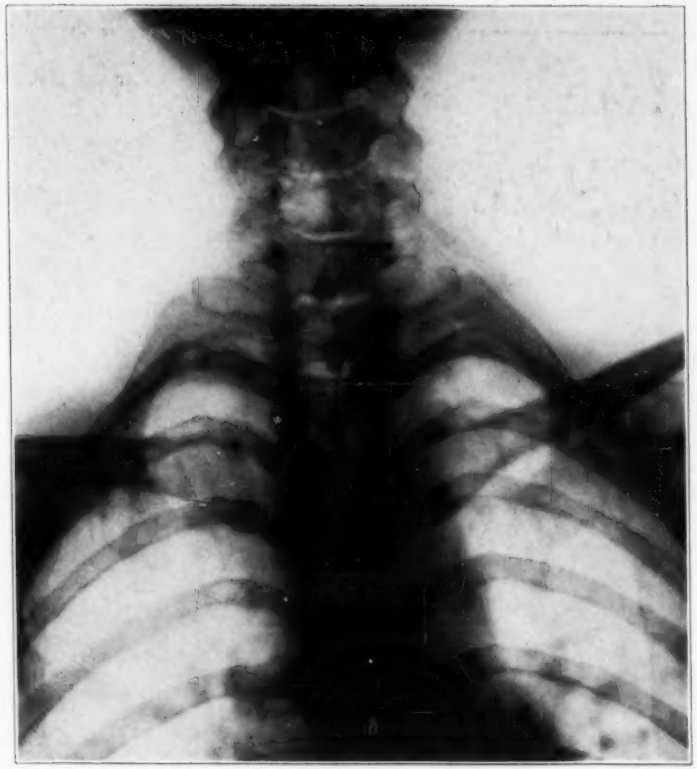

FIG. 7-B

Fig. 7-A: Normal position of the first rib as seen in good body mechanics.
Fig. 7-B: Vertical first rib and drooped chest seen in faulty body mechanics. This position means not only a drag on the structures in the neck, but also a narrowing of the space for these structures.

(Figs. 9-A and 9-B). The correction of the drooped chest and of the extension deformity of the lumbar spine is obtained gradually by exercises planned to correct the habitual faulty position of use. These are begun in recumbency, and progress to the sitting and standing positions, emphasis being laid upon good body mechanics rather than upon the exercises, *per se*. When the ambulatory stage is reached, support for the spine and abdomen is usually necessary.

It is the authors' belief, that when structural, anatomical, and functional abnormalities are present, they are the potential of symptoms which may be initiated with trauma, even though the trauma is relatively slight or is the result of long-standing strain. With this point of view, treatment is planned first to correct the remote causes rather than the local ones,—such as local muscular hypertrophies, or structural abnormalities. It will be found that these remote conditions, as well as the local ones, have been present for a long time before the trauma which started the symptoms occurred. If the remote mechanical causes are removed, in most instances the symptoms will be relieved.

FIG. 8

Lateral view showing not only the vertical position of the sternum, but also the compensatory curves of the spine and other changes in the shape of the body. This patient had a very marked low-cervical extension deformity.

Three patients will be described, in whom the correction of the extension deformity and of the faulty use of the cervical spine, as a part of the correction of the whole body, gave complete relief without any operative procedures, although the authors were ready to operate if necessary. The operative procedure will often give relief of the local symptoms, but it does nothing to correct either the deformities in the cervical spine or the remote causes elsewhere in the body.

CASE 1. This patient was a sixty-five-year-old male, who complained of progressive weakness and pain in the right hand, of three months' duration. The hand was continually cold and at times numb. There was a history of a severe twist of the spine several months before the onset of symptoms. Examination was negative except for the spine, and the right arm and hand. The right elbow was limited in extension to 145 degrees, the result of an injury fifty years before. There was an extension deformity of the cervical spine with accompanying faulty body mechanics which had been getting worse of late. Roentgenograms showed no cervical ribs and minimal hypertrophic arthritis in the cervical spine. The right hand was colder than the left. There was wasting of the muscles of the forearm, and of the thenar and hypothenar eminences and the interossei. There were transient attacks of hypo-aesthesia in the hand and forearm. The laboratory studies were all negative. A complete neurological examination in another clinic showed no evidence of scalenus anterior syndrome. Treatment consisted in correcting the extension deformity of the cervical spine and the faulty body mechan-

FIG. 9-A

Extension deformity of the cervical spine.

FIG. 9-B

Correction of extension deformity with felt cervical collar.

ics, chiefly by bed rest and exercises, followed by the wearing of a support for a number of months. After several months the patient's symptoms entirely disappeared. Four years later the patient reported that there were no symptoms, and there was complete disappearance of the atrophy.

CASE 2. This patient was a man of fifty-six years, who had always done hard physical work until ten years previously, when he began to work at a desk. For the past five months he had had constant pain in the right arm, with numbness and weakness in the entire right arm. Sitting in a barber chair with the neck hyperextended increased the pain in the right arm. Except for increasing obesity, there were no other symptoms. Examination showed a short, heavily built man with an increase in all of the curves of the spine. There was limitation in all movements in the cervical region. Pulling downward on the shoulder or arm did not increase the pain, nor was it decreased by raising the clavicle. There was a tender point at the junction of the middle and outer thirds of the clavicle. Roentgenograms showed no cervical ribs. There were extensive hypertrophic changes at the margins of the fourth, fifth, and sixth cervical vertebrae. Examination, including neurological examination, was otherwise negative. Treatment consisted of eighteen days' hospitalization with special positions and exercises designed to lessen the severity of the deformities of the spine and body. He was shown how to use the neck and body in good mechanics. Symptoms subsided more slowly in this patient. At the present time, almost five years since he was first seen, he has remained free of symptoms except when he becomes careless or fatigued. He has not changed the osseous deformity, but he has corrected in part the old habitual position of the cervical spine, and has thereby lessened the tendency to these symptoms (Figs. 10-A and 10-B).

CASE 3. A woman, thirty-five years old, complained of pain and swelling in the left hand and forearm. Examination showed a short, plump woman with swelling of the entire left hand, extending slightly above the wrist. The hand was tender throughout. Physical and laboratory examination showed no definite evidence of arthritis. Roentgenograms of the cervical spine showed a cervical rib on the right side, but no abnormality

FIG. 10-B

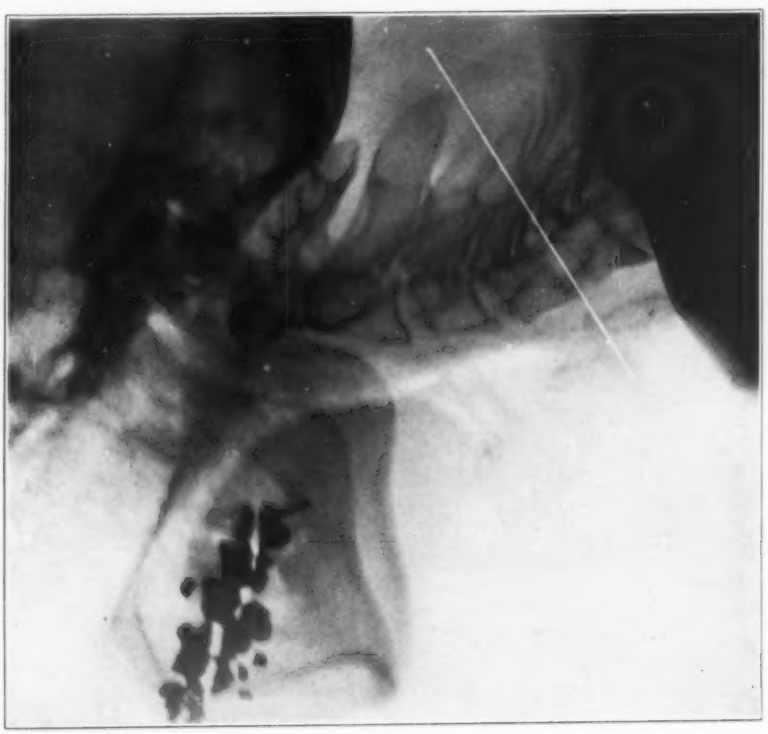

FIG. 10-A

Case 2. Roentgenograms show the extreme extension in the lower cervical spine, and the amount of correction obtained after treatment.

on the left side. Neurological consultation revealed no evidence of scalenus anterior syndrome. Treatment consisted in decreasing the extension of the cervical curve and in correcting the faulty body mechanics. Swelling disappeared in two months and the symptoms have not recurred during the past three years.

As these cases show, there are patients, with symptomatology which suggests a cervical rib or a contracted scalenus anterior, whose symptoms are the result of neurological or vascular irritation from an extension deformity of the cervical spine. When structural or functional abnormalities are present in the cervical region, they are the potential of symptoms which may be initiated by slight trauma when the cervical spine is habitually used in extreme extension. When the extension deformity and the faulty body mechanics are corrected, symptoms will often be relieved. Occasionally operative treatment may be required.

## CONCLUSIONS

The symptoms commonly found in the so-called scalenus syndrome, or with cervical ribs, may be caused by remote factors as well as local ones. These symptoms are frequently due to trauma, either from a definite strain or from the chronic strains which come in the use of the whole body, and especially of the chest and cervical spine, for a long period of time in faulty mechanics, combined with general relaxation and fatigue. In the authors' experience, the correction of the extension deformity of the cervical spine, combined with the correction of the faulty use of the body as a whole, will bring relief of the neurological as well as of the vascular symptoms, in the majority of cases, without the necessity of operative procedures.

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# TUBERCULOSIS OF THE FLAT BONES OF THE VAULT OF THE SKULL

## A Study of Forty Cases

BY C. M. MENG, M.D., AND Y. K. WU, M.B., CH.B., PEIPING, CHINA

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Tuberculosis of the skull has been considered a relatively rare disease, and the literature of the last two decades contains little mention of it; but in those parts of the world in which tuberculosis is still prevalent this impression is scarcely valid. The incidence of tuberculosis in a given community provides a fairly accurate index of the social and economic standards of the population. Where these levels are low the disease flourishes; and where they are as low and the general morbidity of tuberculosis is as high as is the case in China, lesions of the osseous system are common. Under such circumstances it would be illogical to presume that the flat bones of the skull would escape infection. The authors' experience at the Peiping Union Medical College Hospital gives support to this contention.

According to Straus, the first authentic case of tuberculosis of the skull was reported in 1842. Thirty-eight years later, Volkmann published a valuable clinicopathological study of thirty-one cases previously reported and twelve of his own. Subsequently, in 1910, Pelletier collected 206 cases. Only a few cases were added during the next two decades. Straus, in 1933, assembled from the world literature 220 cases and added three of his own. Nakajima recently reported four cases and found only three cases previously described in the Japanese literature. At the Peiping Union Medical College Hospital, tuberculosis of the skull not infrequently has been seen. During a period of fifteen years (1926 to 1940 inclusive) more than seventy cases were

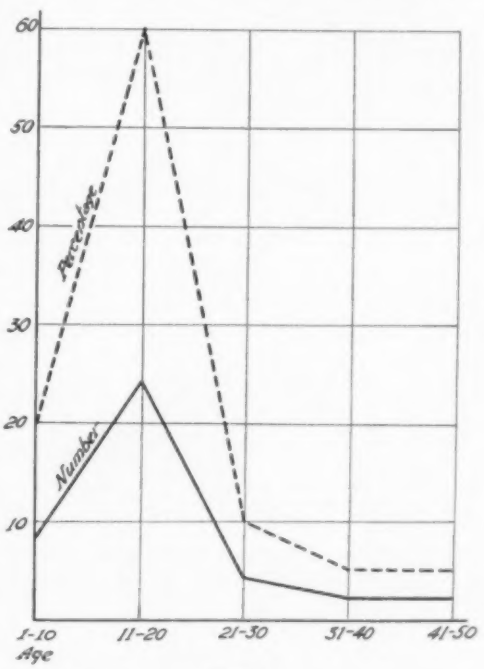


FIG. 1

The frequency of tuberculosis of the skull during various age periods.

diagnosed clinically. Among this number sufficient data to establish definitely the diagnosis were obtained in forty cases. These cases constitute the basis of the present study.

In twenty of the forty cases the diagnosis was established histologically; in five cases it was established by animal inoculation or by culture; and in the remaining fifteen cases the clinical, roentgenographic, and other laboratory findings were such that the diagnosis of tuberculosis seemed justified.

## ETIOLOGICAL FACTORS

### *Sex and Age*

Both sexes are affected, and in this series of cases the male patients slightly outnumbered the female; of the forty patients, twenty-three were male and seventeen were female. There was a marked difference in the frequency of the disease among the various age groups; 80 per cent. of the patients were less than twenty years of age (Fig. 1). Nevertheless, this disease is rarely observed in early infancy or after middle age, although one patient aged seven weeks and another seventy-three years of age have been recorded.

FIG. 2

Photograph of patient (H-72692), aged fifteen, showing an abscess of the right frontal region. Roentgenographic examination of the skull revealed no lesion, but at operation superficial erosion of the frontal bone was found. Pathological study of the tissue revealed tuberculosis. The patient also had tuberculosis of the cervical lymph nodes.

### *Trauma*

Trauma has been considered an important factor in the development of lesions of the skull, in the sense that it may lessen tissue resistance and thereby favor localization of the tubercle bacilli, or in that it may aggravate or bring to light a lesion which has been latent up to that time. In the present series of cases, one patient only gave a history of direct injury to the head. In this instance the injury was sustained one week prior to the onset of a swelling (Fig. 2), which was said to have appeared and disappeared a number of times in the beginning, and to have become persistent only after a period of two years. Even after the lapse of this time, the lesion could not be demonstrated in roentgenograms, and only superficial erosion of the bone was observed at operation. The authors are inclined to believe that while trauma may be contributory, it is not an important or an essential factor.

### *Associated Tuberculous Lesions*

The finding of tuberculous lesions in other parts of the body in patients suffering from tuberculosis of the skull is common. Among the forty patients in this series, such lesions were present in 85 per cent.

TABLE I

ASSOCIATED TUBERCULOUS LESIONS IN THIRTY-FOUR PATIENTS

| | | |
|---|---|---|
| Chest | | 22 |
| Lung | 18 | |
| Pleura | 3 | |
| Pericardium | 1 | |
| Bone and joint | | 77 |
| Facial bones | 9 | |
| Thorax | 18 | |
| Spine and pelvis | 10 | |
| Extremities | 40 | |
| Lymph nodes | | 6 |
| Cervical | 5 | |
| Axillary | 1 | |
| Abdomen | | 5 |
| Peritoneum | 3 | |
| Intestine | 2 | |
| Skin | | 4 |
| Total number of associated lesions | | 114 |

Eleven patients had a single associated lesion and twenty-three patients had multiple lesions numbering from two to fifteen per patient. In six patients associated tuberculous lesions were not found. Four of these patients, however, were seen in the Out-Patient Clinic, where complete examinations were not made. In twenty-eight patients of whom roentgenograms of the chest were taken, pulmonary lesions compatible with tuberculosis of varying extent and activity were revealed in sixteen. A clinical diagnosis of pulmonary tuberculosis without roentgenographic confirmation was made in two other patients. Excluding the four cases in which incomplete examinations were carried out, pulmonary tuberculosis was found to be present in eighteen, or 50 per cent.

Bone and joint tuberculosis was found in twenty-seven patients and formed the majority of the associated lesions (Table 1). It was of special interest to note that in patients with multiple lesions of bone, all of these lesions not infrequently appeared within a short space of time. This observation concerned particularly those patients showing lesions of the facial bones. In six of the nine patients with lesions of the mandible or other facial bones, the lesions of the skull appeared more or less simultaneously with the facial lesions. The frequent observation in this series of the coexistence of lesions of the flat bones other than those of the skull is another interesting fact. Among the forty patients, the facial bones were involved in nine instances, the sternum in five, the scapula in four, and the pelvic bones in three. Since tuberculosis of the flat bones is relatively uncommon, this frequent coexistence of lesions in more than one flat bone might suggest that only a certain strain of tubercle bacilli is able to flourish in the scanty cancellous tissue of these bones. According to

Wegemer, Lange has suggested the bovine type of tubercle bacillus as the offending organism. The authors have good reason, however, to doubt that this particular organism was the causative agent in their cases, and are more inclined to believe that the sudden appearance of multiple lesions is an indication of a breakdown of the general resistance of the patient.

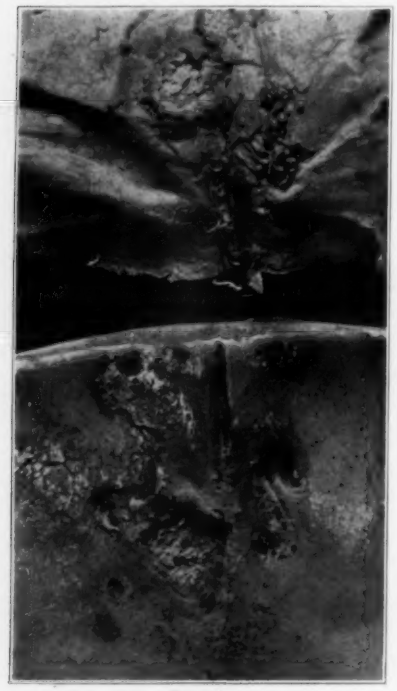

FIG. 3

W. Y. S. (H-27346), a male, forty-one years old, died of extensive tuberculosis involving the lungs, intestines, liver, spleen, mesenteric and bronchial lymph nodes, and skull. One lesion of the skull involved both tables and the other the inner table only. The Wassermann reaction of the blood was strongly positive. The lesion involving the inner table of the skull is shown here. Note the scarred appearance of the external surface of the dura. The cerebral surface of the dura was not involved.

## PATHOLOGY

### *Pathogenesis*

Tuberculosis of the skull as a primary lesion must be exceedingly rare, although Koenig estimated that one-fifth of all cases were primary, and Straus considered that cases of primary tuberculosis of the skull are not at all uncommon. The authors believe that this lesion is practically always secondary to a focus elsewhere in the body. The detection of the primary focus may be difficult, and the degree of success depends upon the thoroughness of the search. Failure to find it makes the lesion of the skull only apparently primary. Occasionally the skull may be involved as a result of the direct extension of a neighboring tuberculous lesion (as from the mastoid or the orbit), but lesions of this type have not been included in this study.

It is generally believed that when the disease is blood borne, it attacks the diploe first and then extends to involve the inner and outer tables. Which of the tables is involved first is still a controversial point. In one patient, there was no external evidence of disease of the skull before death, but on postmortem examination two isolated lesions were found. One of them involved both tables and the other the inner table only (Fig. 3). In another patient, postmortem examination revealed, in addition to a known lesion with draining sinus involving both tables, a second lesion involving only the inner table (Fig. 4). However, the question of whether one or the other table is first involved is of more academic than practical importance. In most cases, by the time the disease has become manifest, both tables of the skull have been invaded. Occasionally the lesion starts from the periosteum, as is definitely illustrated by two of the cases. The dis-

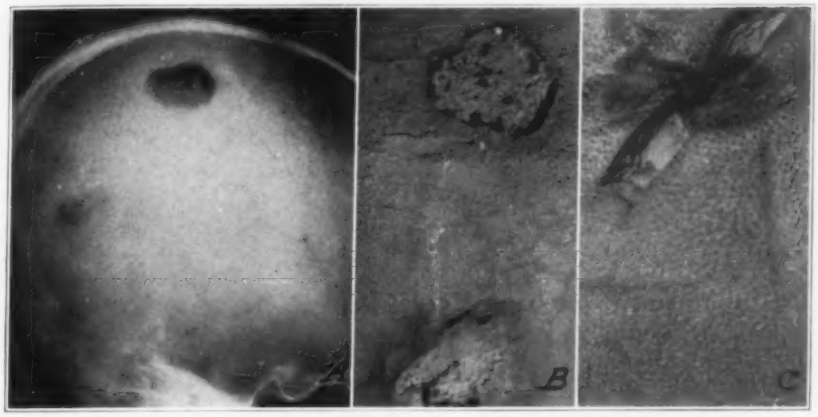


FIG. 4

W. K. C. (H-19660), a male, twenty-nine years old, died of extensive tuberculosis involving the lungs, skin, scapula, elbow, sternum, intestines, axillary and mesenteric lymph nodes, and skull. The Wassermann reaction of the blood was positive.

*A:* Roentgenogram showing the location of the lesions, the thickening of the skull, and the increased density of the bone.

*B:* Photograph of the inner table of the skull. Note the size of the sequestrum in the upper lesion.

*C:* Exterior view. Note the size of the defect in the outer table as compared to that of the sequestrum. The lower lesion involved the inner table only.

case also may start from the dura and secondarily involve the skull, although no such case was observed in the present series.

*Pathological Types*

1. The circumscribed (perforating) type of lesion described by Volkmann presents one or more well-circumscribed areas of destruction, involving at first one table, and having a tendency to perforate the entire thickness of the bone. A well-formed sequestrum, corresponding to the shape of the defect, is commonly seen (Figs. 4 *A* and 4 *B*), but bone sand also has been observed to fill the defects. In those cases in which the lesion seems to have originated from the inner table, it is not unusual to find the sequestrum larger than the opening in the outer table (Figs. 4 *B* and 4 *C*). In the present series of forty cases, all except two belong to this type as is evidenced by the roentgenographic, operative, or postmortem findings. In about half of them, the defects were round or oval with well-defined outline, and varied from a few millimeters to two centimeters in diameter. In the other cases the defects were irregular with ill-defined edges. Occasionally two closely situated, well-circumscribed lesions had become confluent (Fig. 5).

2. In the diffuse (infiltrating) type of lesion described by Koenig, the disease starts in the diploe, spreads through the latter structure progressively, and involves the compact tables as it extends, causing multiple perforations. Clinically this type of lesion is believed to occur more commonly in children. Lenormant and Soupault, on the basis of the findings in one of their cases, suggested that the extension of the dis-

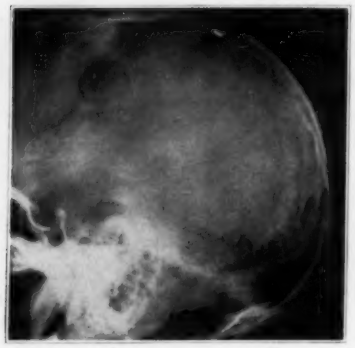

FIG. 5

S. H. M. (O.P.D. 450957), a male, twenty-five years old, had tuberculosis of the sternum, fibula, spine, foot, lungs, and skull. This roentgenogram of the skull shows multiple circumscribed lesions and the presence of sequestra. Note particularly the absence of bone reaction around the lesions, and the two adjacent lesions which have become confluent.

FIG. 6

W. H. C. (O.P.D. 423790), a girl, fourteen years of age, had a swelling over the parietal region for two years, with later rupture and the formation of a large ulcerative pulsating lesion. The Wassermann reaction of the blood was negative. The roentgenogram showed an extensive, diffuse lesion of the parietal bone. The clinical diagnosis was tuberculosis, but the roentgenographic diagnosis was syphilis. Tuberculosis was demonstrated histologically only after biopsy had been performed on four occasions.

ease process is not through the diploe, but through a layer of tuberculous granulation which forms between the inner table and the dura (beginning from the primary site of perforation), and subsequently invades the bone at multiple points. St. John contended that the circumscribed and the diffuse types are but two different stages of development of a

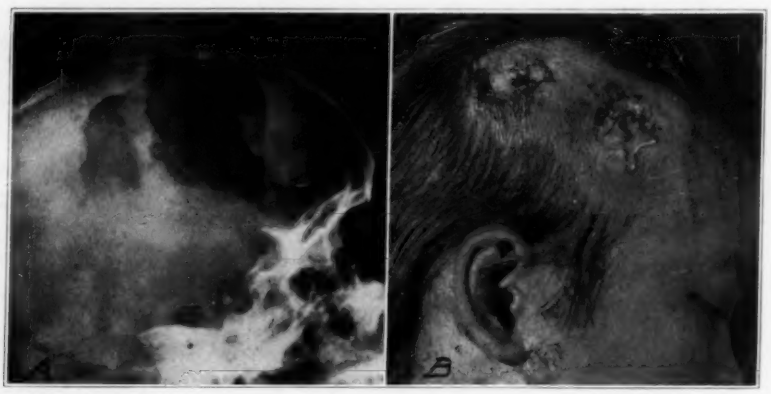

FIG. 7

S. C. Y. (O.P.D. 451803), a girl, fifteen years old, complained of having ulcerative, pulsating, discharging lesions over the parietal region for more than two years. There also were lesions characteristic of tuberculosis in the lungs, ribs, and spine. The Wassermann reaction of the blood was negative. Biopsy of the lesions of the skull revealed tuberculosis.

*A* shows extent of the diffuse lesions.

*B* shows the external appearance of the lesions.

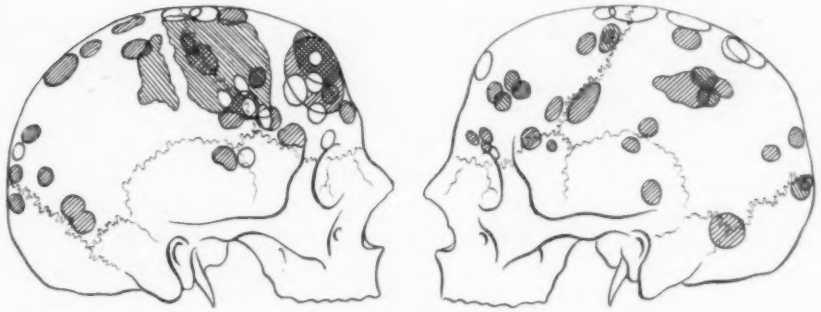

FIG. 8

Topographic distribution of the lesions in thirty-nine cases. The shaded areas are proved lesions and the unshaded areas probable lesions. One large lesion, involving practically the entire left parietal bone (in another case) is separately illustrated in Fig. 6.

common lesion, and considered that multiple perforations of the skull are only the external representations of a single focus in the bone. In the present series, two cases were of the diffuse type (Figs. 6 and 7).

In either type of lesion, as the disease perforates the outer table of the skull, a subperiosteal abscess is formed. This abscess may remain as a small, palpable, firm, non-tender mass for some time. Subsequently it may rupture through the periosteum and form a softer mass in the subcutaneous tissues; eventually it will find its way to the exterior with the formation of a chronic discharging sinus. The location of the abscess and the sinus corresponds closely to the underlying lesion in the bone. Occasionally, however, the abscess may gravitate to a lower level, and the sinus may be found a short distance away from the actual site of the lesion of the bone.

When the inner table is perforated, the underlying dura may be thickened and covered by caseous material or granulation tissue. The cerebral surface of the dura, however, appears normal. Furthermore the dura frequently is observed to be adherent to the edges of the bony defect. These observations tend to refute the theory of Lenormant and Soupault regarding the mode of extension of the diffuse, infiltrating type of lesion along a layer of granulation tissue formed between the dura and the inner table; they also may account for the rare development of cerebromeningeal symptoms in tuberculosis of the skull. Only ten cases of tuberculous meningitis and five cases of cerebral tuberculosis were observed in 223 cases collected by Straus. This complication was not observed in the authors' cases.

*Number and Location of the Lesions*

A single lesion (including the diffuse type) was present in twenty-three of the forty cases, and multiple lesions varying in number from two to four were observed in the remaining seventeen cases. The location of the lesions was determined by roentgenographic examination, by autopsy,

and by operation. In seven cases a single lesion involved two adjacent bones, crossing the line of suture in each instance; in another case the lesion occurred at the junction of three bones. Several of these patients were less than twenty years of age. It was evident that the suture line did not form a barrier against the spread of the disease. The sites of these lesions are illustrated topographically in Figure 8. The frontal and parietal bones were the most frequently affected, and both sides of the skull were fairly evenly involved. That the lesions are mostly situated in the frontal and parietal bones usually finds explanation in the fact that these bones are more exposed to trauma. From observation of cross sections of the various bones of the skull, it is the authors' belief that the frequent involvement of these two bones is due to the comparatively greater amount of cancellous bone and diploic structures present in them.

## CLINICAL MANIFESTATIONS

The onset invariably is insidious. Many of the patients came to seek treatment for lesions of other parts of the body, and the lesion of the skull was discovered on physical examination. The first local manifestation is the development of a swelling. It usually is not painful unless complicated by secondary infection. At first it is small, firm, and fixed to the skull, but gradually it increases in size and softens, to form a fluctuating cold abscess which shows little or no tenderness. It not infrequently is mistaken for a sebaceous cyst or lipoma. Pulsation of the swelling, synchronous with the radial pulse, may indicate perforation of both tables of the skull. When secondarily infected, the lesion may not be easily distinguishable from an ordinary pyogenic abscess, and for such it not infrequently is incised and drained. A typical chronic tuberculous ulcer or draining sinus (Fig. 7*B*) eventually forms after either spontaneous rupture or surgical incision of the swelling. If the whole thickness of the skull is eroded over a large area, pulsation of the dura may be clearly visible at the bottom of the wound. Occasionally a small area of alopecia around the ulcer may be present.

Among the forty patients, cold abscesses were present in eighteen; these abscesses were single in fifteen instances and multiple in three. The diameter of the abscesses ranged from one to seven centimeters. A definite bone defect could be felt around the base of the abscess in several instances. In twenty patients a draining sinus or sinuses were present. One patient had both a cold abscess and a draining sinus, and in another patient, who died of active pulmonary tuberculosis, there was no evidence of disease of the skull externally, and the lesion was discovered only on postmortem examination.

Symptoms referable to involvement of the meninges or the cerebral cortex, although mentioned by other authors, were not observed in the present series. It may be worthy of note that most of the patients remained afebrile and in fair general nutritional condition, except for a few who harbored active pulmonary or intestinal lesions.

## DIAGNOSIS

In the absence of a swelling or a discharging sinus, the patient rarely has any complaint suggestive of this disease, and hence an early diagnosis is infrequent. In a tuberculous individual, especially a child or an adolescent, great care should be exercised to palpate carefully the bones of the head. When a swelling or a sinus is present, in addition to other tuberculous lesions, especially of the bones of the face, the diagnosis of tuberculosis of the skull should be considered until disproved.

*Tuberculin Test:* In children a positive tuberculin test affords additional evidence to support the diagnosis. A negative result following repeated tests is of far more value in ruling out the disease. In the present series, tuberculin tests were carried out in six patients below the age of twelve years, and all gave strongly positive reactions.

*Blood Wassermann Reaction:* Differential diagnosis between tuberculosis and syphilis of the skull is frequently difficult, particularly in adults, and for this reason a sample of blood always should be taken for serological tests. In the present series, Wassermann and Kahn tests were performed in all but four cases. In those instances in which there was clinical or roentgenographic suspicion of syphilis, the tests were repeated. Positive tests were obtained in only three patients. It happened that one of these three patients, who had been thought to have syphilis of the skull by both the syphilologist and the roentgenologist, was found on postmortem examination to have tuberculosis instead (Fig. 4). A second patient with a positive Wassermann reaction had multiple lesions involving the skull, mandible, phalanges of the feet, rib, and lungs. Tuberculosis was found in the skull, phalanges, and rib, from which tissue was removed. A positive Wassermann reaction, therefore, does not necessarily exclude the diagnosis of tuberculosis of the skull.

FIG. 9

W. S. C. (O.P.D. 444004), a male, eighteen years of age, complained of having an abscess of the forehead for more than five months. Physical examination revealed lesions suggestive of tuberculosis of the pelvic bones, right shoulder, peritoneum, and sternum. The Wassermann reaction of the blood was negative. Tubercle bacilli were found in pus aspirated from the abscess of the head. In the roentgenogram can be seen a perforated lesion of the frontal bone surrounded by a thick zone of increased density. Compare with Fig. 5.

*Roentgenography:* Although roentgenography is an important aid in the diagnosis of lesions of the skull, it occasionally fails to disclose early, superficial, periosteal tuberculous lesions. Contrariwise, the visualization of actual lesions by roentgenograms does not necessarily mean that they are tuberculous. The findings often are so varied and confusing that an incorrect diagnosis can easily be made. In many instances, therefore, it is im-

FIG. 10

C. Y. C. (O.P.D. 94126), a Chinese male, aged forty-eight years, had multiple sinuses of the scalp for more than two years, and a fusiform swelling of the right elbow for more than one year. These lesions were thought to be syphilitic. The blood Wassermann reaction was negative on four different occasions. Because of the previous history of multiple venereal exposures, antiluetic treatment was given and continued for ten weeks without improvement. The condition of the elbow became worse and finally was proved to be tuberculous by animal inoculation. The lesion of the skull probably was tuberculous also; its roentgenographic appearance evidently was modified by secondary infection.

perative for the roentgenologist to know at least the essential facts of the clinical record, and the nature of the associated lesions, if any are present. The usual roentgenographic picture is that of one or more circumscribed, round or oval, punched-out bone defects, in which a definite sequestrum or bone sand may be observed, and about which there may be no reaction, or a zone of increased density extending from one to two centimeters peripherally (Fig. 9). Tuberculosis of the skull is predominantly a destructive lesion, which shows little evidence of osteoplastic repair. Occasionally, however, exuberant osteogenesis may be observed along with osteolytic changes in cases in which multiple discharging sinuses or ulcerative wounds of the scalp are present. Diagnosis in these cases is often extremely difficult, and, if in addition, a positive Wassermann reaction or a previous luetic history is present, one may easily be led astray (Figs. 4 and 10). As mentioned previously, the majority of tuberculous lesions of the skull are represented by well-defined round defects, usually not larger than two centimeters in diameter. Still in some cases the lesions appear irregular in shape, less distinct in outline, and of fairly large size. It may be added that, in order to localize the lesions accurately, it is often necessary to take roentgenograms of the skull from various positions.

*Aspiration:* Unless contra-indicated, this procedure is of distinct diagnostic value. In a tuberculous abscess, the pus frequently contains caseous material. It is seldom possible to find tubercle bacilli in the pus on ordinary smear examination. However, the organism can frequently be demonstrated by culture or by animal inoculation. In this series, culture was employed four times, with positive results in three cases. Animal inoculation was carried out in three cases, and a positive result was obtained in each instance. In one of these latter cases a positive culture also was present.

*Biopsy:* When there is an open ulcer or a sinus, a biopsy of the granulation tissue gives valuable information. The finding of characteristic tubercles and acid-fast bacilli in the tissue establishes the diagnosis. A single negative finding, however, does not exclude the disease, particularly when the sinus has been of long duration or is secondarily infected. Repeated attempts at biopsy are often necessary. In one of the cases, the diagnosis was established only after the fourth biopsy had been made. It is important that the specimen be taken from a relatively deep part of the sinus. In some cases an exploratory operation is necessary to establish the diagnosis. In the present series of forty cases, the diagnosis of tuberculosis was established in twenty by study of the tissue specimen.

## DIFFERENTIAL DIAGNOSIS

A swelling of the scalp due to a tuberculous lesion of the skull may easily be mistaken for a lipoma, a sebaceous cyst, or, if it is secondarily infected, a pyogenic abscess. When an osseous defect is discovered in the roentgenogram, it is not uncommonly interpreted as of syphilitic origin. Tumors of the skull such as osteosarcoma, myeloma, endothelioma, and metastatic carcinoma occasionally may be confused with a tuberculous lesion. Under the title of "Tuberculosis and Polyuria", Hand, in 1893, described unknowingly the first case of xanthomatosis of the skull. It is needless to say that careful clinical investigation aided by various laboratory tests is essential in order to avoid error.

## PROGNOSIS

The prognosis of patients with tuberculosis of the skull depends upon several factors: (1) the state of the general health; (2) the extent of the local lesion; and (3) incidentally, the early establishment of a correct diagnosis. When the patient is seen at an advanced stage of the disease, with associated active pulmonary or intestinal lesions, the condition usually is hopeless. On the other hand, if the patient is seen early and the general health is good, even in the presence of multiple associated lesions, the prognosis is still fair if the proper general and local treatment can be carried out. Locally, a single circumscribed lesion has a much better prognosis than is the case when multiple diffuse lesions are present. It is lamentable to record that so many of the authors' patients did not seek treatment until they presented a condition for which one hesitated to entertain any hope.

## TREATMENT

The general well-being of the patient must be the first consideration, as much of the success of the local treatment depends upon the patient's general state of health. Therefore, adequate supportive measures must be provided for these patients just as for patients with tuberculous lesions elsewhere in the body.

Whenever possible, the local treatment consists in complete excision of the diseased tissues. The sequestrum usually can be picked out easily.

The diseased bone should be rongeured away until healthy bone is reached. In the perforating or circumscribed type of lesion, the dura, which usually is adherent around the defect, should not be disturbed. Following excision, the incision should be closed without drainage. The wound should be left open only when there has been a discharging sinus or an ulcer. A large bone defect resulting from the operation is undesirable and should be avoided if possible.

In the present series, operative treatment was carried out in only eight instances. All of the lesions were of the circumscribed type. In four cases the lesions had perforated the whole thickness of the skull,—in one had involved the outer table alone, and in the other three had involved only the superficial layer of the outer table. In four cases the wounds healed *per primam*. In the other four cases, in which sinuses had been present before the operation, the wounds healed from one to ten months later.

Experience gained in the treatment of these patients makes the authors feel that in well-selected cases, local excision yields satisfactory results, and should be practised more frequently. Occasionally high-voltage roentgen therapy may be employed locally. Such therapy was carried out in one of the cases as the only form of treatment, and in another two cases as postoperative treatment, with favorable response in all. This experience, together with observations of the effect of high voltage roentgen rays upon tuberculous lesions of other parts of the skeleton, leads to the belief that this type of therapy may be of help in certain cases in which local excision is impossible, or in which healing of the wound following operation is slow.

## SUMMARY AND CONCLUSIONS

1. Forty cases of tuberculosis of the skull have been analyzed and the clinicopathological aspects of the disease discussed.

2. Tuberculosis of the skull is not rare in parts of the world where tuberculosis is prevalent. It is an affection predominantly of childhood and adolescence.

3. Tuberculosis of the skull is practically always secondary to an active or latent tuberculous lesion elsewhere in the body. It is frequently associated with pulmonary lesions and those of bones and joints. Not infrequently tuberculosis of other flat bones may coexist in the same individual.

4. The lesion usually is of the circumscribed type often represented clinically by a painless cold abscess or discharging sinus.

5. A correct diagnosis usually can be made if this condition is kept in mind, particularly if tuberculous lesions are found in other parts of the body. Occasionally, however, difficulty is encountered in differentiating tuberculosis from other destructive lesions, notably syphilis. Laboratory examinations following aspiration or biopsy have proved of much value and should be employed whenever possible.

6. Roentgenographic examination is helpful, but is not always reliable, and at times may be quite misleading.

7. A cure can be reasonably hoped for in selected cases, if local excision is carried out, but in the majority of cases the condition is so far advanced that treatment consists of simple local dressings. In a few cases high-voltage roentgen therapy has proved beneficial.

8. Whatever the local treatment may be, the fact should be appreciated, that patients with a tuberculous lesion of the skull are suffering from a tuberculous disease and, for this reason, require adequate general antituberculosis care.

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# PELVIC FRACTURES AND DISLOCATIONS REDUCED BY TURNBUCKLES

BY HOWARD DUDGEON, JR., M.D., WACO, TEXAS

In describing the results obtained in reducing severe fractures and dislocations of the pelvis by the use of turnbuckles as described by Jahss, the author assumes that all other complications usually present in this type of injury have been cared for.

The only types of traction suitable for pelvic fractures, or dislocations with marked displacement, are compression medially or expansion laterally, depending upon the injury present. The only means by which this can be done successfully is the use of turnbuckles incorporated in plaster. The only material needed for making this apparatus is five six-inch turnbuckles and a few bolts. Two turnbuckles are used between the thighs,—one directly in front of the other and parallel to it (Fig. 1). These two turnbuckles are manipulated at the same time during reduction. They are applied on the leg at the junction of the middle and upper thirds of the femora. Three six-inch turnbuckles are attached together with bolts and applied two inches above the internal malleoli.

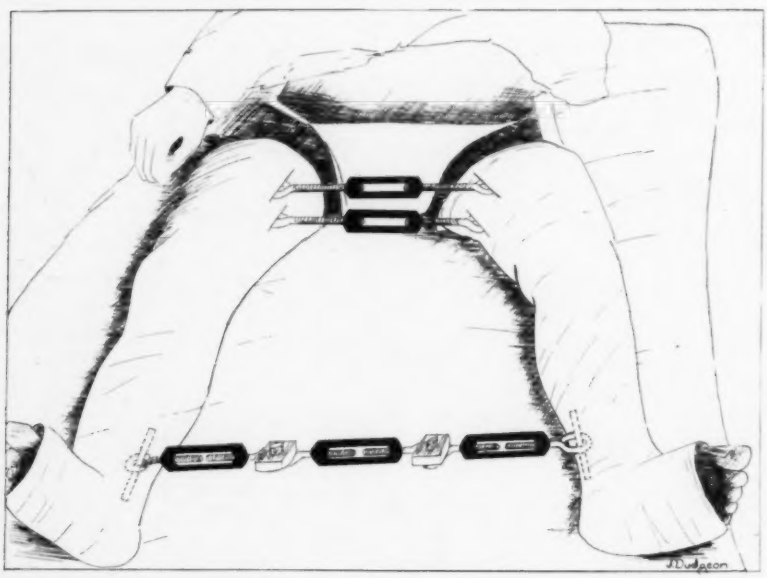

FIG. 1

The cast has been applied as it was in Case 1, and the reduction is to be started. The upper turnbuckles are to be slowly closed, and the lower ones slowly opened. Several turns of the turnbuckles will be made twice a day. Note at the ankles how the turnbuckles are held in the plaster; the aluminum strips are shown by dotted lines. The proximal turnbuckles are fixed to the plaster in a similar manner.

Whether the turnbuckles are applied open or closed depends upon the fracture.

A well-padded cast is applied from the toes to the groin bilaterally. After the plaster drys, the turnbuckles are incorporated, as shown in Figure 1, and are attached to the cast by several rolls of plaster. Strips of aluminum are run through the eyes of the turnbuckles to aid in attaching them to the plaster. The plaster is allowed to set for twenty-four hours before the manipulation of the turnbuckles is started.

Traction is applied in a horizontal plane by the turnbuckles. Both lower extremities are used as levers and pressure is applied through pull on the ligaments of the hip joints and on the ilia. This must be borne in mind as it is the basic principle of this type of traction.

CASE 1. A. R., a corporal, aged twenty-two, was injured on March 10, 1941, in a car wreck. The symphysis pubis was separated two and one-half inches, and the left sacro-iliac joint was dislocated. He was in extreme shock; later a large extraperitoneal abscess developed. Because of his serious condition, it was twenty-two days before an attempt could be made to reduce the fracture of the pelvis. At the time the cast and turnbuckles were applied, the pelvis was in the condition shown in Figure 2-A. A roentgenogram

FIG. 2-A

Case 1. Roentgenogram taken at time of admission to Station Hospital, twenty-two days after injury, and before any reduction had been attempted.

FIG. 2-B

Case 1. Roentgenogram, taken fourteen days after the turnbuckles were applied, and thirty-eight days after the injury, shows reduction of the pubis.

FIG. 2-C

Case 1. Final result six months after injury. The left sacro-iliac joint remains unreduced, but is painless. The patient has returned to light duty at Camp Bowie, Texas.

FIG. 3-A

Case 2. Roentgenogram, taken at the time of injury March 24, 1940, shows the head of the femur pushed through the acetabulum, with marked displacement.

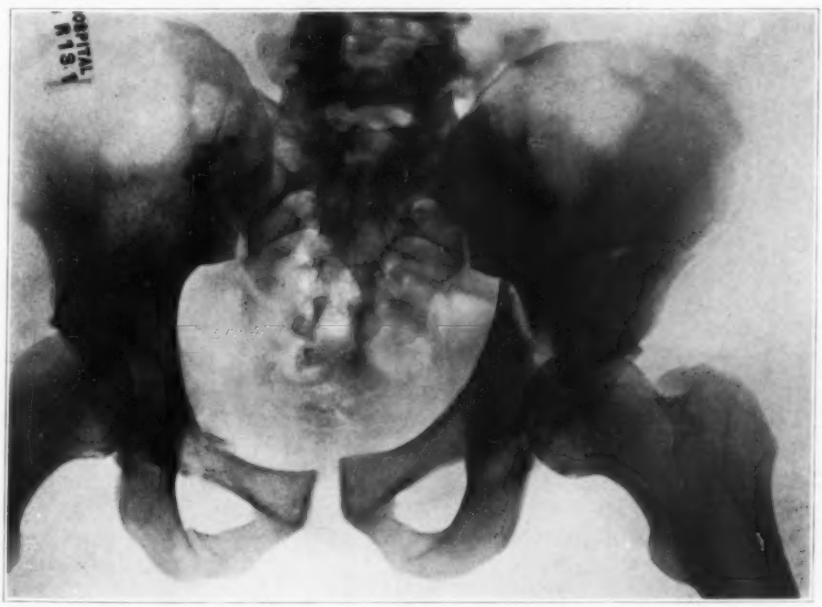

FIG. 3-B

Case 2. Roentgenogram, taken March 28, 1940, shows the reduction of the fracture-dislocation by the use of turnbuckles.

taken two days later (Fig. 2-B), shows the reduction. Still later results are shown in Figure 2-C. The dislocation of the left sacro-iliac joint could not be reduced. When removed from the cast, the patient had complete foot-drop on the right, probably due to pressure from the cast on the common peroneal nerve at or behind the head of the fibula, but this had improved considerably by October 20, 1941, when he returned to light military duty, and had cleared up completely by November 25, 1941. He had no pain at this time.

In this case the upper turnbuckles were put in wide open and the lower ones completely closed. The upper ones were slowly closed, and the lower ones slowly opened over a period of ten days. The symphysis pubis was reduced first as it was considered the most important injury. The author was unable later to reduce the left sacro-iliac dislocation.

CASE 2. G. P., aged thirty-five, colored, while drunk, fell off a railroad bridge fifty feet to the river bank, and received a fracture-dislocation of the left acetabulum, with the head of the femur being rammed into the pelvis (Fig. 3-A). Plaster and turnbuckles were applied and the fracture was easily reduced in three days. The patient was kept in plaster for six weeks, and was allowed to bear weight at the end of eight weeks. He made a complete recovery in four months (Fig. 3-B). There have been no arthritic changes so far in this man.

In this case the upper turnbuckles were put in closed, and the lower ones open. The upper were slowly opened, and lower ones were slowly closed.

The author has seen two cases of pelvic fracture in women who had very considerable overlapping of the pelvic fragments. These were young women, desirous of having children. Turnbuckles were used, and excellent reductions were obtained.

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# ABDUCTION OSTEOTOMETER

BY HENRY MILCH, M.D., NEW YORK, N. Y.

During the course of a series of studies undertaken to elucidate the factors influencing upper femoral osteotomy, a number of interesting data were disclosed and have been reported upon elsewhere [2, 3, 4]. Generally speaking, osteotomy has been employed to produce (1) changes in the direction of the femoral axes, (2) changes in the position of the femur relative to the pelvis, and (3) changes in the comparative length of the two femora. Though an alteration in either one of these relationships may represent the primary indication for the operative intervention, it is manifestly impossible to accomplish the desired effect without at the same time inducing changes in each of the other relationships. A mature appreciation of the result of femoral osteotomy must, consequently, include a means of evaluating and simultaneously controlling each of these components.

Variation in actual length of the femoral shaft can usually be measured clinically with considerable accuracy. However, by far the greatest disparity in leg length arises, not from actual shortening, but from the apparent shortening which is caused by pelvic obliquity attendant upon ankylosis of the hip in abnormal positions. The problems to which this gives rise are complicated, and are far from solution. Some progress in the solution of the difficulty has been made by the observations of Lovett, Seddon, and others, on the relationship between the angle of abduction or adduction, and the difference between the true and apparent lengths of the limbs. The importance of these observations cannot be denied, but their validity can be admitted only provided it be stipulated that the difference in apparent length of the two limbs is due entirely to lateral inclination of the pelvis. This, of course, is not invariably true, since anteroposterior tilting of the pelvis, resulting from fixed flexion of the hip, may similarly lead to apparent shortening, which becomes greater as the angle of flexion increases (Fig. 1).

To establish the shortening which is due to adduction alone and, therefore, the angle of abduction necessary to correct the deformity, it is essential to deduct from the total the amount of shortening which is due to flexion alone. This is by no means a simple problem. In fact, it appears that by the methods at present employed, no completely accurate estimate of the degree of actual flexion of the hip can be obtained and, therefore, no adequate correction for the distortion can be made. To overcome this difficulty, it has been suggested that the present uncertain approximations be eliminated in favor of a more objective clinical measurement, based on the determination of the pelvifemoral angle [5]. By the use of this angle, it is possible to determine the apparent shortening which is due to flexion. Subtracting this amount from the total yields the

apparent shortening which is due to adduction and which can be corrected by abduction osteotomy. (This amount must be increased by a little over one-half inch to compensate for the 15 degrees of flexion, which is desirable, so as not to interfere with the patient's sitting position.)

The failure to make allowance for these factors in the tables prepared by Seddon, Lovett, and others, probably accounts, in part, for the excessive lengthening not infrequently observed after abduction osteotomy. But there are other reasons for questioning the validity of these tables. It is to be noted that they are based on two primary assumptions: (1) that the osteotomy is to be performed at the extreme upper end of the ankylosed femur, and (2) that the femur is a straight bone of the

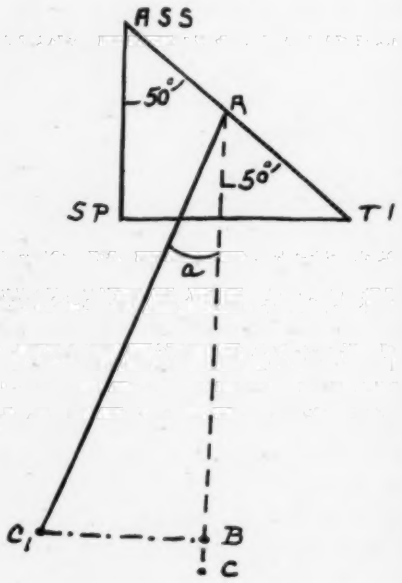


FIG. 1

*ASS* = Anterior superior spine. *SP* = Symphysis pubis. *TI* = Tuberosity of the ischium.

The line joining *ASS* to *SP* is in the frontal plane. The line joining *ASS* to *TI* is Nelaton's line. It lies in the axial plane of the pelvis and makes an angle of 50 degrees with the frontal plane. The femur, *AC*, in the extended position, is parallel to the frontal plane and makes a pelvifemoral angle of 50 degrees with Nelaton's line. The angle *a* is the angle of flexion deformity. $AC - AC_1 = L$ (the length of the femur). The shortening (*S*) due to flexion = $BC = (AC - AB)$. Since $AB = L \cos a$, $S = L - L \cos a$.

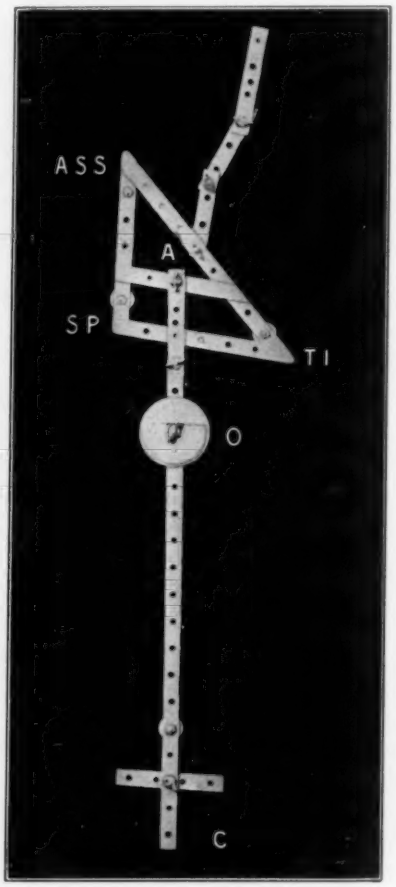


FIG. 2

Model of lateral outline of the pelvis and femur. The vertical bar *ASS* to *SP* represents the frontal plane in which the anterior superior spines and the symphysis pubis lie. The horizontal bar *SP* to *TI* represents the plane in which the symphysis and the ischial tuberosity lie. *A* represents the hip joint. The femur is approximately parallel to the frontal plane and makes an angle of about 50 degrees with the axial plane of the pelvis.

broom-stick type. These are obviously not consistent with the clinical facts.

Abduction osteotomy is but seldom, if ever, performed at the upper end of the femur,—that is, through the hip joint. Though this may be, theoretically, the ideal site for osteotomy, practical experience has established the preference for other levels, especially in the subtrochanteric region. Since the angle of abduction indicated by the tables is estimated on the assumption that the osteotomy is to be performed at the hip joint, the choice of any other osteotomy site necessarily involves a corresponding change in the angle of abduction, if the same effect is to be accomplished. It has been shown [4] that the lower the level of osteotomy, the greater must be the angle of abduction. Moreover, it can be shown that the lower the level of osteotomy, up to the mid-point of the bone, the greater is the degree of femoral shortening which is due to the osteotomy itself. It is, therefore, apparent that, before determining the desired angle of abduction, the tables must be further modified, so as to take into account the level at which the osteotomy is to be performed.

Still other factors must be taken into consideration. These are the angle of the femoral neck and the length of the femoral neck. The effect of abducting a femoral neck already in valgus will be entirely different from that accomplished on a neck in marked varus. Abduction of the distal, femoral

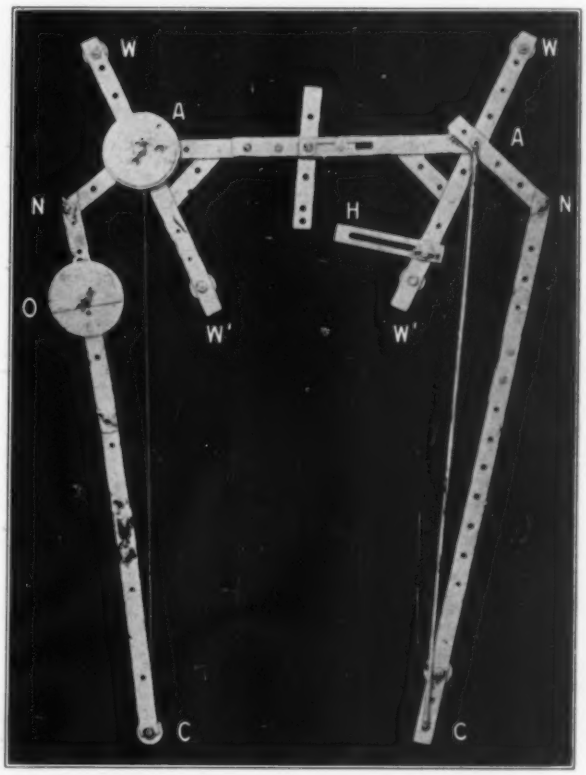


FIG. 3

Model of the anteroposterior outline of the pelvis and femora, for use in unilateral cases. The inclination of the outer pelvic wall (*WW'*) is fixed at 210 degrees to the midline. *AN* represents the neck of the femur, *NC* the shaft of the femur, and *O* indicates the site of osteotomy. The slotted bar *H* is a brake to limit adduction of the left femur. *AA* represents the interfemoral distance.

The spring *AC* uniting the right femoral head to the midcondylar area represents the mechanical axis. The effect on the mechanical axis of abduction at the hip joint, of abduction at the base of the femoral neck, or below the trochanter, can be measured by means of the inserted arcs.

fragment is clearly identical with abduction of the proximal fragment in relation to the distal portion of the osteotomized femur, and abduction of the proximal fragment is equivalent, within certain limits, to increasing the valgus of the femoral neck and thereby of increasing the actual length of the femur. But simultaneous with this increase in length, due to increasing valgus of the neck, there occurs an associated shortening of the femur, due to angulation of the shaft. The resultant change in length will, therefore, depend upon the reciprocal relationship between these two effects.

Yet even this does not exhaust the difficulties inherent in what has been considered the simple osteotomy procedure. The femoral neck introduces still another disturbing element in the already hectic problem,—the mechanical axis of the femur. Though stress is actually distributed through the neck to the anatomical axis or shaft of the femur, function must be considered as occurring along an imaginary line—the mechanical axis—which extends from the femoral head to the mid-condylar region. When the term "parallelism of the legs" is used, it is "parallelism of the mechanical axes" and not of the anatomical axes that is intended. The measure of useful abduction is, therefore, not the amount by which the shaft of the femur has been angulated, but, on the contrary, the degree to which the mechanical axis has been shifted.

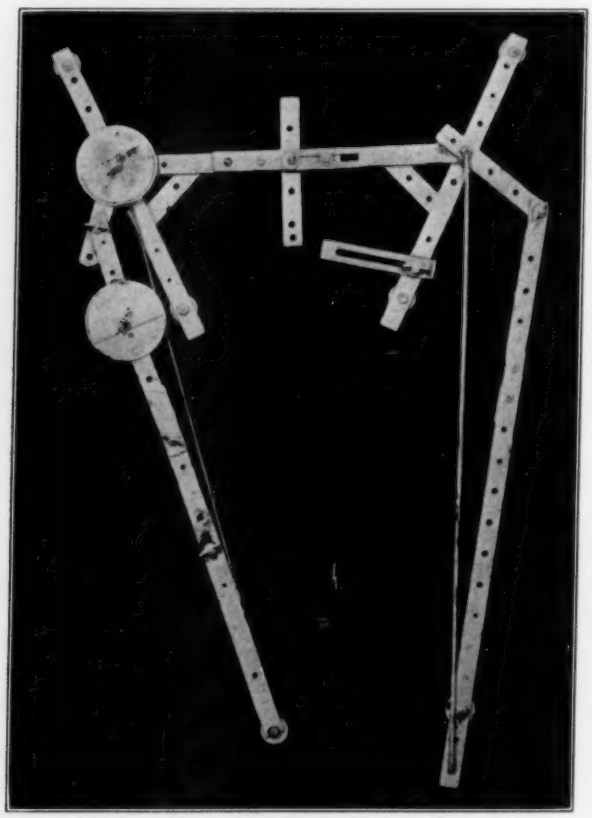

FIG. 4

The right hip is ankylosed. The right femoral shaft is one and five-eighths inches shorter than the left. The femoral neck on the right side is one inch shorter than the left. Yet, by actual measurement, the right femur is only one and one-half inches shorter than the left, because of the increased length which resulted from increasing the angle of the right femoral neck from 125 degrees to 150 degrees.

While the physiological effect of osteotomy is acquired from a change in the position of the mechanical axis, it is surgically accomplished by an-

gulation of the anatomical axis. At first sight, this would not seem to present any serious obstacle. Since the abduction of the mechanical axis is dependent upon that of the anatomical axis, it would appear reasonable to surmise that the measure of abduction of the one might be taken to be the measure of abduction of the other. However, it soon becomes apparent that the clinical estimation of abduction of the anatomical axis is an extremely inaccurate guide to the degree of abduction of the mechanical axis. In the course of the previously mentioned studies, it was found that the level at which the osteotomy was performed profoundly modified the results obtained. It was observed that, under certain circumstances, the position of the mechanical axis could be made to vary without changing the angle of abduction of the distal portion of the osteotomized femur. Under other circumstances the position of the mechanical axis could be fixed, even though the abduction of the osteotomized femur were increased or decreased.

From the survey of all of these considerations, and from the realization of the intimate relationship of all these different factors, it was appreciated that osteotomy of the femur so altered the relative positions of the anatomical and mechanical axes that no simple and invariable statement of these relationships could be devised. Indeed, the mathematical statement of the interrelationships would involve the calculus of several variables and result in a formula so complicated as to be of no practical, clinical value.

In the solution of this difficulty a pelvic model, made from steel parts resembling an erector set, proved of incalculable value

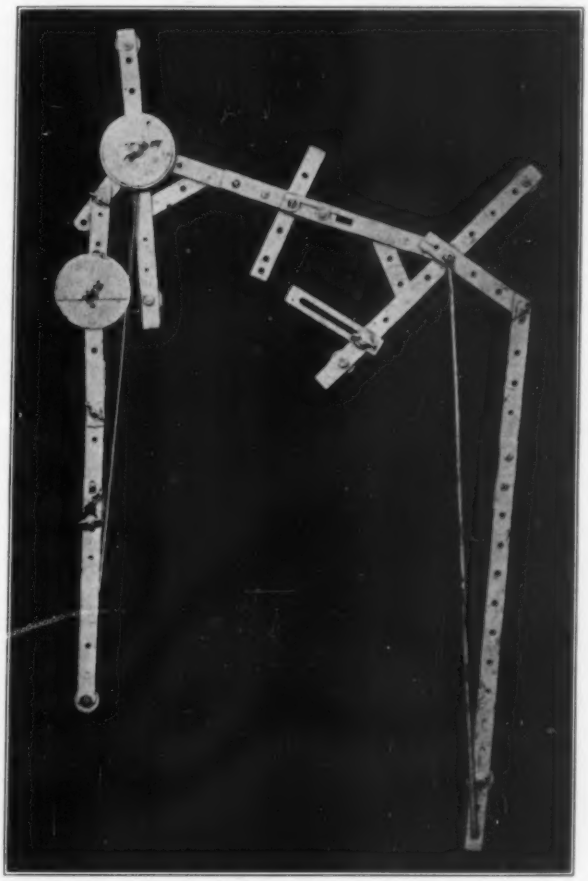

FIG. 5

The legs have been made parallel by tilting the left pelvis *downward* about 13 degrees. This has resulted in an apparent shortening of about four inches.

(Figs. 2 and 3). Though it was originally intended merely as a manikin for teaching purposes, it was found that when adjusted to anatomical dimensions it could be made to serve as an instrument of considerable precision. By its use, the angle of abduction of the anatomical axis necessary to achieve the desired change in the position of the mechanical axis, while at the same time preserving parallelism and equality of limb length, may be easily determined preoperatively.

The apparatus has been made so that the roentgenographic measurements of actual cases may be reproduced. The present model has been devised for the study of unilateral conditions, and the left side is represented as normal. By duplicating the construction of the right side, the model may be adapted to the study of bilateral conditions. The width of the pelvis may be modified, but the inclination of the outer wall of the pelvis has been fixed at approximately 210 degrees. By the conversion of the fixed union into a movable joint, the angle of inclination of the pelvic wall may be adjusted to any desired angle. The upper end of the femur is joined to the pelvis by a set screw passing through at the level of the acetabulum. The hip joint may be permitted to remain mobile, or may be locked to simulate ankylosis at any angle of lateral deviation. Another joint has been made at the top of the femoral shaft, so that the angle of the femoral neck may be changed or fixed at will. By means of the series of drill holes or slots, the length of the femoral neck and of the femoral shaft may be altered. At a point about four inches below the base of the femoral neck, a joint inserted into the femoral shaft simulates

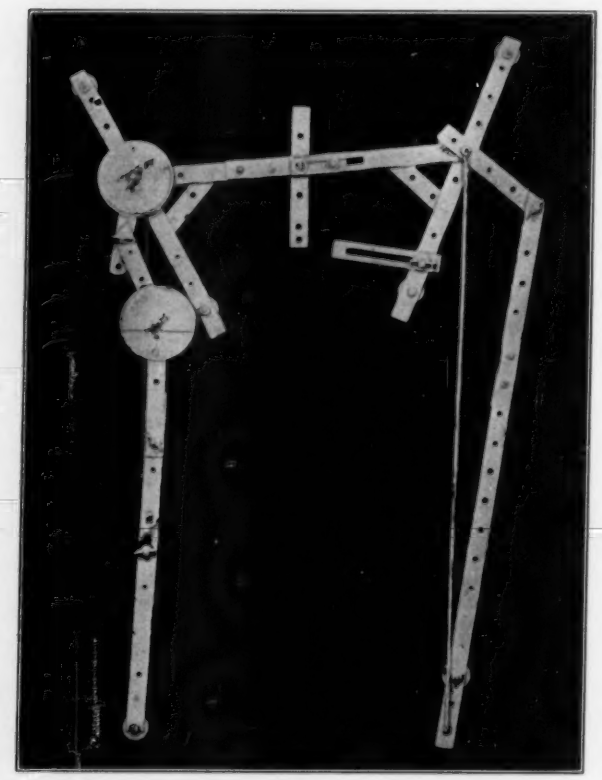

FIG. 6

Osteotomy performed four inches below the base of the femoral neck. In order to restore "parallelism of the limbs", and correct the apparent difference in length, the distal fragment must be abducted 30 degrees from its former axis. This results in a fixed *upward* tilt of the left pelvis of about 8 degrees.

an osteotomy level, and permits measurement of the degree of abduction or adduction of the distal fragment.

The method of application and the clinical value of the device, may, perhaps, best be exemplified by the following hypothetical illustration. Let it be assumed that the conditions found in a given patient are as seen in Figure 4. As the result of a suppurative process, the right leg has become ankylosed in a position of adduction. The flexion component may be disregarded, since it does not exceed 15 degrees. The right femoral shaft, from the tip of its trochanter to the condyles, measures sixteen and seven-eighths inches, as compared with the left, which measures eighteen and one-half inches. There is actual shortening of the right head and neck to two inches, as compared with three inches on the left side. The angle of the right femoral neck is 150 degrees, as compared with the left, which has remained at 125 degrees. By actual measurement, the right femur, from the hip to the knee, measures eighteen and one-half inches, while the left measures twenty inches.

The real difference in length is one and one-half inches. When both mechanical axes are brought into parallelism (Fig. 5), the left side of the pelvis is tilted downward and the left leg is apparently lengthened, so that the apparent difference between the two legs is increased to four inches, an increase of two and one-half inches over the real shortening. According to the tables for lateral deviation, prepared by Lovett, the difference of two and one-half inches between the real and apparent lengths of the femora in a pelvis eleven inches wide, indicates an adduction of 13 degrees in the affected femur. According to Seddon's table, the adduction of the affected femur must be considered as being not greater than between 8 and 10 degrees.

According to the tables of either Lovett or Seddon, abduction of 10 to 15 degrees should lead to adequate correction of the deformity, with regard both to restoration of parallelism of the limbs and to parity in their apparent lengths. Reference to the model, however, reveals that this is not the fact. Indeed, the divergence between the observed and calculated results is so great that it renders the tables not only useless, but, in fact, misleading.

In Figure 6 it can be seen that when the osteotomy is performed at a distance of four inches below the base of the neck, the distal fragment of the femur must be abducted to an angle of 30 degrees from the axis of the proximal fragment, in order to restore the parallelism of the limbs and at the same time to overcome the apparent difference in limb length. This results in a fixed *upward* tilting of the pelvis of about 8 degrees on the side opposite the affected limb. The total shift of the left pelvis from minus 15 degrees to plus 8 degrees, is sufficient to compensate for the actual shortening of one and one-half inches, and the apparent shortening due to the adduction deformity. By implication, it would seem that abduction of the femur 23 degrees would accomplish this result, as indeed it would, provided the osteotomy were performed at the level of the hip joint.

Though this degree of abduction is greater than would have been believed from the use of the standard tables, it is still less than the 30 degrees indicated by the osteotometer. This is, of course, due to the fact that the osteotomy has been performed at a level four inches below the acetabulum.

## SUMMARY

Because of the presence of the femoral neck and the conversion of the femur into a hockey-stick shape, simple osteotomy of the upper end of the femur entails a number of complicated changes, which cannot be calculated by any simple table of relationships. To facilitate the calculations which are necessary in the performance of an upper femoral osteotomy, a mechanical model has been constructed.

The device here suggested provides a relatively easy method for determining, preoperatively, the exact site and angle of deviation for any abduction osteotomy of the femur. It permits the experimental study on a pelvic model of the effect of osteotomy in any given femur. It eliminates the necessity of cumbersome tables and immediately establishes the resultant of a number of variable factors to be considered in osteotomy. By appropriately adjusting the model to the measurements, as determined by roentgenograms, the postoperative result can be checked and adequate correction made before union has occurred at the site of osteotomy. The apparatus is simple to operate and both simple and inexpensive to construct.

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# ANGIOMA OF THE FOOT *

BY SAMUEL KLEINBERG, M.D., F.A.C.S., NEW YORK, N. Y.

Primary angioma of bone is *clinically* uncommon in any part of the skeleton, but especially so in the bones of the extremities. Clinical manifestations appear only if the tumor has destroyed enough of the bone to cause its collapse, or has expanded the bone so that there is pressure on the adjacent soft tissues, causing pain or some functional disturbance. Asymptomatic angiomata of bones, notably the vertebrae, are found frequently at autopsy. Töpfer found an incidence of 11.93 per cent. in 2,154 spines. Presumably there are many angiomata in other bones without clinical evidences.

FIG. 1-A

January 20, 1940. Lateral view of the right foot.

Note the partial disappearance of the cuboid and external cuneiform bones, and the numerous cysts of varying size and shape surrounded by thin walls. There are many phleboliths.

An angioma in bone produces marked and rather characteristic, but not pathognomonic, roentgenographic changes. In the vertebrae there are vertical columns of dense bone separating rarefied areas. In the flat bones the dense trabeculae of bone are so arranged as to give a sunburst appearance. In the long bones the lesion is commonly seen as a multiloculated change which replaces the bone, but which does not perforate the periosteum or the epiphyseal plate. The frequency with which angiomatous lesions affect bone in contrast to other tissues can be judged by the figures quoted by Geschickter and Keasbey. They

* The text is based on a presentation made before the Orthopaedic Section of the New York Academy of Medicine, November 21, 1941.

found that among 570 angiomata collected at the Johns Hopkins Hospital, there were twelve instances of primary involvement of bone, about 2 per cent. In the Radiographic Department of the Hospital for Joint Diseases, where thousands of patients are x-rayed every year, only three or four angiomata of bones in the extremities have been seen in the last ten years.

Lillian Z., nineteen years old, consulted the author on January 3, 1940, for pain in the sole of the right foot, and a limp. The limp had been present intermittently for eleven years; recently it had become pronounced. The pain, formerly occurring only occasionally and only as a mild discomfort, increased in severity, so that the girl was decidedly disabled. Her mother stated that even during her early childhood the patient tired easily and was disinclined to walk, so that it may be fairly assumed that the lesion in the foot had its inception during childhood.

The examination revealed an individual in seemingly good general condition, who walked with a decided limp on the right side. There was a mild atrophy in the right thigh and leg. A mass, about the size of an egg and exceedingly tender to pressure, was seen and felt on the plantar surface of the right foot. It was soft, elastic, deep-seated, diffuse, and non-pulsating. There was no tumefaction on the dorsum of the

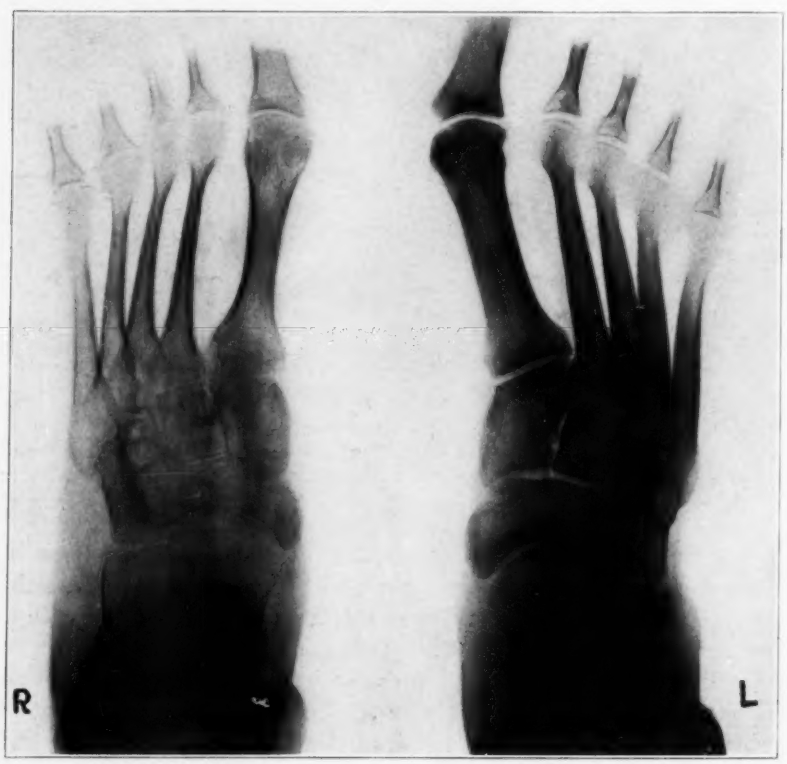


FIG. 1-B

January 20, 1940. Dorsoplantar view of both feet. (Roentgenogram reversed.)
There is a multiple cystic disease of the cuboid and external cuneiform bones, and marked atrophy of the metatarsals, in the right foot.

foot, but pressure over the cuboid and cuneiform bones caused moderate pain. The hip, knee, ankle, and toe joints were freely movable.

The roentgenograms (Figs. 1-A and 1-B) of the foot showed an extensive destructive lesion in the cuboid and external cuneiform bones. In the cuboid the inner two thirds were involved, and in the cuneiform the entire bone appeared to be affected. The osseous tissue was replaced by cystic areas which varied in size and shape, and which were surrounded by narrow walls of bone of lesser or greater density. In some areas the trabeculae of bone were very sclerotic. The other bones of the foot appeared to be underdeveloped, especially the metatarsals. The exact diagnosis was not certain, but from the history, the chronic course of the illness, and the absence of any evidence of invasiveness, it seemed very likely that the condition was a benign tumor. Accordingly, an operation for excision of the neoplasm was advised and performed.

FIG. 2

Photomicrograph (×20) of a portion of the external cuneiform bone. Note the numerous blood spaces lined by endothelium and separated by thin connective-tissue walls.

*Operation.* On February 29, 1940, the mass in the sole of the foot was palpated and its location definitely noted before a tourniquet was applied. It was well that this had been done because, following the application of the Esmarch bandage, the mass could no longer be felt. This observation promptly suggested a vascular lesion. A three-inch incision was made on the medial side of the plantar surface of the foot, exposing between the first and second layers of muscles a mass of varicose veins,—that is, an angioma. Further dissection revealed that the mass was made up of blood vessels which had entered it from all directions. Anteriorly some of these vessels had entered the tarsal bones. As many main vessels as possible were ligated, leaving a removable mass as big as a prune. The tourniquet was released, and no bleeding was found in the wound, which was thereupon closed in layers without drainage. A two-inch incision was then made on the dorsum of the foot, and was deepened to bone. From the external appearance of the bone, except for a slight lateral displacement of the cuboid on the os calcis, there was no evidence of a tumor. However, upon cutting through and reflecting the thin cortex on the outer surface of the cuboid, the cancellous bone was found to be replaced by a vascular neoplastic tissue which was readily removed with a curette.

FIG. 3-A FIG. 3-B

Roentgenograms made twenty months after operation. The cystic areas in the cuboid are replaced by bone of a substantial structure. The removed cuneiform bone is represented by only a small shadow of bone.

The external cuneiform was almost completely replaced by tumor tissue and was excised practically *in toto*. There was very little bleeding. Both wounds healed by primary union.

The pathological examination showed that the mass removed from the sole of the foot was angiomatous and contained many phleboliths. The cuneiform was greatly rarefied, only a shell remaining, and was filled with angiomatous tissue. The microscopic examination (Fig. 2) showed a capillary hemangioma with considerable blood pigment in the supporting tissue and phleboliths in all stages of organization and calcification.

Since all of the angiomatous tissue could not be and was not removed, the patient was given deep x-ray therapy of 750 roentgen units directed to the plantar and to the dorsal aspects of the foot, making a total of 1500 roentgen units, which was considered adequate by the roentgenologist.

The foot remained swollen and sensitive for many months. Weight-bearing was avoided for the greater part of a year, by the end of which time all symptoms had disappeared. At present there is no sensitiveness on pressure and she can walk without pain. Roentgenograms (Figs. 3-A and 3-B) taken in October 1941 showed that the operative defect in the cuboid has been almost completely replaced by bone of normal texture. In the gap between the cuboid and the middle cuneiform, some normal bone has been deposited.

There is here reported a case of a benign capillary hemangioma of a foot, involving the cuboid and the external cuneiform bones and the soft tissue in the sole of the foot. There was undoubted vascular communication between the lesion in the bones and that in the plantar area. It is not possible to state in which of these areas the angioma began. Perhaps, as in other cases with multiple lesions, the angioma appeared in the various areas simultaneously. The angiomatous growth evidently started many years previously, in childhood, and, while it had periodically caused some symptoms, these were not severe until shortly before the patient was seen by the author when, because of marked pain and disability, she was compelled to seek relief. The roentgenograms presented a characteristic multicystic appearance, yet the diagnosis was not made until the time of operation, when the disappearance of the mass after a tourniquet was applied to the thigh suggested the probable pathology. Healing progressed very slowly and swelling of the foot persisted for a long time, but at the present time the patient has no symptoms and is apparently cured.

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# OSTEOCHONDRITIS JUVENILIS OF THE ACETABULUM *

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Although more than 700 articles have been written on osteochondritis of the centers of ossification, few authors have mentioned the acetabulum. As far as can be ascertained, only one writer, Froelich, described a case of osteochondritis in which the acetabulum was involved without obvious involvement of the neighboring head of the femur. In this case, both acetabula were involved and the changes described were similar to those presented in the authors' cases.

The authors believe that the acetabulum is involved much more often than generally is recognized, either with the head of the femur or alone. In order to substantiate this view three cases are reported in which the acetabular structure was involved without obvious involvement of the neighboring head of the femur, and two cases in which the acetabulum was involved in conjunction with the femoral heads and other centers of ossification.

## REPORT OF CASES

CASE 1. A boy, fourteen years of age, was admitted to the Gillette State Hospital for Crippled Children on September 5, 1935, complaining of pain in the right hip with an accompanying slight limp of one year's duration. Examination of the hips revealed only slight limitation of motion. Anteroposterior roentgenograms revealed irregular areas of decreased and increased density, fuzziness, mottling, marginal proliferation of bone, and fragmentation which involved the iliac or superior half of both acetabula (Fig. 1-A). The patient was confined to bed and the pain promptly disappeared. He was dismissed from the Hospital on December 13, 1935. It was necessary to hospitalize him again for twenty-two days in August and September, 1936, because of recurrent symptoms. However, with rest in bed these promptly disappeared.

Motions of both hips were entirely normal when the patient was last examined on May 11, 1939, and roentgenograms on that date revealed entirely normal acetabula (Fig. 1-B).

CASE 2. A girl, ten years of age, was admitted to the Hospital on March 22, 1941, complaining of pain in the right hip accompanied by a limp of six weeks' duration.

Examination revealed an apparent increase of one inch (2.5 centimeters) in the length of the right lower extremity. Abduction and external rotation of the right hip were moderately restricted. Roentgenograms on admission revealed that the superior border of the right acetabulum was fragmented and fuzzy, although the epiphysis of the femoral head appeared normal (Fig. 2-A).

Treatment consisted of Buck's adhesive extension with traction of eight pounds (3.6 kilograms) to the right leg and application of a Thomas splint to maintain the extremity in abduction. The pain disappeared immediately. Fifty-three days after admission, the patient was dismissed as clinically and subjectively cured. However,

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FIG. 1-A

Case 1. September 6, 1935. Areas of decreased and increased density, with marginal proliferation of bone and fragmentation involving the iliac portions of the acetabula, may be seen, although the heads of the femora are entirely normal.

FIG. 1-B

May 11, 1939. The acetabula are smooth, of normal density, and of entirely normal appearance.

FIG. 2-A

Case 2. March 24, 1941. There is extensive fragmentation of right acetabulum, with a question of formation of loose bodies at the junction of the iliac and pubic portions; the head of the femur does not appear involved, although osteoporosis is already apparent.

roentgenograms taken on April 21, 1941, revealed no improvement; if anything, the fragmentation was more marked (Fig. 2-B). On further study of the roentgenograms, it was thought that beginning involvement of the femoral epiphysis could be detected, but this was not certain.

CASE 3. A girl, one year of age, was admitted to the Hospital on April 28, 1932. Roentgenograms revealed congenital dislocation of the right hip. Treatment consisted of traction on a Coonse abduction frame. The patient was dismissed on December 15, 1932, with a complete range of motion in the hip, and the condition was apparently cured. She was examined at regular intervals. At the last examination on February 20, 1941, at which time the patient was ten years of age, she walked without a limp. Reaction to the Trendelenburg test was negative. Roentgenograms revealed that both femora were in adequate acetabular cavities, although the acetabula, especially the right acetabulum, gave evidence of circulatory disturbances (Fig. 3).

In the next two cases, although changes were present which predominantly involved the acetabula, the roentgenograms also revealed changes in other centers of ossification.

CASE 4. A boy, nine years of age, entered the Hospital on October 22, 1931, complaining of pain in the left inguinal region, which extended down the left thigh to the knee. Onset of symptoms dated back about a month prior to admission, at which time he had fallen from a porch and had struck the lateral side of the left thigh.

Examination revealed moderate limitation of flexion and internal and external rotation. Roentgenograms revealed a suggestive area of decreased density, about two or three millimeters in diameter, in the epiphysis of the left femoral head, and definite

Fig. 2-B

Case 2. April 21, 1941. Changes are even more marked than in Fig. 2-A. Osteoporosis of the head is more pronounced, and there may be slight involvement evidenced by the small, punched-out area where the postacetabular margin bisects the femoral epiphysis.

Fig. 3

Case 3. February 20, 1941. Both acetabular cavities are involved, especially the right. On careful examination three or four small, loose bodies can be distinguished in the joint.

FIG. 4-A

Case 4. October 22, 1931. Changes, especially marked on the left, extend into that portion of the triradiate strip formed by the junction of the iliac and pubic bones; the epiphysis of the left femoral head is also involved.

FIG. 4-B

March 29, 1934. Acetabular changes are not so marked, and the triradiate strip is no longer involved on the left, where fusion is almost complete. Fusion has not progressed to the same extent on the right and there is still some involvement of the triradiate strip. The punched-out area in the left femoral epiphysis has completely disappeared.

FIG. 5-A

Case 5. May 9, 1939. The acetabula are extensively involved, as are also the heads and necks of the femora. Several loose bodies can be distinguished in the joint spaces.

FIG. 5-B

March 9, 1940. Involvement of the acetabula is more marked than in Fig. 5-A.

mottling, with areas of increased and decreased density, which involved the superior portions of both acetabula (Fig. 4-A).

Treatment consisted of traction followed by a plaster-of-Paris cast of the short hip-spica type. This was removed after one and a half months, and the patient was dismissed on February 11, 1932; marked improvement had occurred. Roentgenograms at this time disclosed marked improvement, and the change in the femoral epiphysis was hardly detectable.

The last roentgenograms of the hips were taken March 29, 1934 (Fig. 4-B); although changes in the acetabula were still present to a slight extent, they were not as marked as previously.

FIG. 5-C

Case 5. January 17, 1940. Osteochondritis of practically all lumbar and thoracic vertebrae.

CASE 5. A boy, eight years of age, was admitted to the Hospital on May 9, 1939. There was roentgenographic evidence of definite osteochondritis involving the lumbar vertebrae, the heads of both femora, and the acetabula, with enlargement of the acetabular cavities and rarefaction and condensation of bone (Figs. 5-A and 5-C). In this case the roentgenographic appearances of the acetabula are of interest. The most recent roentgenograms, taken on March 9, 1940, disclosed progression rather than regression of the condition (Fig. 5-B).

## COMMENT

The three primary centers of ossification which form the ilium, ischium, and pubis are present at birth; however, at this time the greater part of the acetabulum is cartilage. By the tenth year of life the cartilage in the three bones at the acetabulum is reduced to a triradiate strip. Two or three secondary centers appear in this strip, one of which forms the os acetabulum at the age of twelve years[3]. From the ages of the patients affected and their roentgenographic appearances, the disturbance seems to have been in the primary centers, with the possible exception of Cases 2 and 3. Furthermore, inasmuch as the superior

or weight-bearing surface of the acetabulum was chiefly involved, it would appear that the iliac center of ossification at the acetabulum is most likely to be affected, although it is not illogical to assume that the other centers also may be involved.

Several authors, Jansen in particular, described the variations of contour of the acetabulum which accompany osteochondritis of the femoral epiphysis. At an early date the acetabulum is widened, either actually or relatively and the depth of the cavity is diminished. Jansen was of the opinion that these changes preceded those in the femoral head, but most writers have considered them secondary. Waldenström stated[9]: "There is no change in the shape of the acetabulum at first, this change taking place secondarily, as an adaptation of the socket to the deformed caput, and only after some time." He further stated that only when the head assumed its final shape was this adaptation of the socket complete. Gill agreed with Waldenström, but in addition stressed that the acetabulum does not become altered if it is protected from the forces of weight-bearing and muscle pull exerted on and through the softened head. Platt stated that in the later stages: "The final shape of the hip-joint socket is in conformity with the final shape of the head", and this has been demonstrated by most observers time and again.

The writers agree with these authors that this is the natural variation of contour in the acetabulum in those cases in which the structural variation is confined to the head and neck of the femur. It is, however, with the structural variations of the acetabulum that we are chiefly concerned. These have been described by Platt in conjunction with the Legg-Calvé-Perthes type of osteochondritis. Regions of condensation and rarefaction, with an appearance similar to that of the femoral neck adjacent to the epiphyseal cartilage, are present in the subchondral portion of the bone. For the details the authors recommend King's excellent summary of the changes which occur in osteochondritis juvenilis in the acetabulum, as well as in the other centers of ossification.

They disagree with other authors concerning these structural changes, for they believe that, in a certain percentage of cases, structural changes similar to those in the femur take place in the acetabulum coincidentally with, and not secondarily to, the changes in the femoral head and neck. They further believe that in certain, perhaps isolated, cases there is a structural change in the acetabulum, without any detectable change in the head and neck of the femur.

The cases reported substantiate this view, for it would seem that the primary changes were in the acetabulum. However, in those cases in which alterations in the femoral head were present, acetabular changes were coincidental with, and not secondary to, those in the former. It seems, therefore, that when structural changes occur in the acetabulum, these changes are either primary or in conjunction with the changes in the femoral head, whereas the variations in the contour of the acetabulum are mainly secondary to the changes in the femur.

In the cases reported, clinical symptoms were unilateral, yet in practically all instances both acetabula presented roentgenographic evidence of changes of varying degree. The authors are not prepared to say whether this represented potential involvement of the other hip. Along this same line of thought, Outland and Flood reported two cases of osteochondritis dissecans of the acetabulum, in which the roentgenograms revealed that all four hips contained loose bodies, in spite of the fact that the symptoms were referable to only one hip in each case.

In Case 3, the changes followed an excellent result of treatment of a congenitally dislocated hip during the second year of life by means which were practically atraumatic. In reviewing a series of cases of congenital dislocation of the hip, several cases were found in which changes in the femoral epiphysis and acetabulum were present. However, Case 3 is the only case found in which changes in the acetabula only were present. Time alone will tell whether clinical symptoms will eventually present themselves in this case.

Little or nothing can be added to the entangled and theoretical discussion relative to the etiology of osteochondritis juvenilis, but the authors are of the opinion that this condition, at least in these cases, is probably due to a circulatory disturbance which is possibly aggravated by trauma. This is evidenced by the fact that the structural changes seem to involve the superior or weight-bearing surface of the acetabulum, while the inferior surface is little affected.

Treatment should be along the same lines as that used for the type of osteochondritis affecting the femoral epiphysis,—namely, rest of the involved part. Whether this is secured by rest in bed, traction, crutches, Thomas walking calipers, or by casts seems to matter little. Judging from the two cases in which healing took place, there seems to be little, if any, residual deformity; therefore, rest probably does not need to be as strictly enforced as in the Legg-Calvé-Perthes type of osteochondritis.

## SUMMARY AND CONCLUSIONS

The literature presents comparatively little concerning osteochondritis juvenilis affecting the acetabulum. Only one case has been reported previously in which the acetabulum was involved without changes in the corresponding epiphysis of the femoral head. In three of the cases, the acetabula were involved without changes detectable roentgenographically in the femoral epiphyses. In addition, two cases were reported in which other centers of ossification also were involved.

Osteochondritis juvenilis of the acetabulum may affect the primary centers of ossification or it may involve the secondary centers. The change is most likely to occur at the superior rim or surface of the acetabulum. Treatment is conservative and should be directed toward relief of the strain which results from weight-bearing on the involved region. An analysis of the two cases in which healing took place reveals the fact that there seems to be little, if any, remaining deformity.

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# PROGNOSIS IN BONE AND JOINT TUBERCULOSIS

## An Analysis of the Results of Treatment and a Consideration of the Factors Which Influence the End Result *

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What result may be expected from treatment of tuberculous bones and joints? This can only be determined by the careful examination of the results over a long period of time. Tuberculosis of bones and joints is a disease easy to alleviate, but hard to cure. The achievement of cure, moreover, is profoundly influenced by a variety of ancillary factors, apart from the manner of treatment. The analysis which follows is an attempt to determine the present status of all the cases of bone and joint tuberculosis which have been treated in the Toronto Hospital for the Treatment of Tuberculosis, Weston, and to determine the factors which influence the prognosis.

### MATERIAL AVAILABLE FOR STUDY

In the ten years between January 1931 and December 1940, there were discharged from the bone-and-joint wards of the Weston Sanatorium 307 patients, of whom it has been possible to follow 296 up to the present time,—a period of from one to ten years. In these 296 cases, 356 lesions of bones, joints, and associated structures were recognized. As the hospital accommodation is chiefly for adults, only twenty-five (8 per cent.) of this group were children under twelve years of age. At the time of admission to the Hospital, the youngest patient was two and one-half years of age, and the oldest seventy years of age,—the majority falling into the age group between fifteen and forty-five years of age. The etiology has been proved bacteriologically in 70 per cent., but roentgenograms, history, and clinical examination have had to be relied upon in the remainder. All cases in which there seemed to be the slightest doubt of tuberculous origin have been excluded. The fact that 20 per cent. of the patients with hip lesions admitted to the Hospital as tuberculous have not been included in this analysis, is an indication of the difficulty experienced in making a certain diagnosis of tuberculous arthritis in many cases. For this reason, every effort is put forth to obtain material for bacteriological culture at the time of the patient's admission to the Hospital, or as soon afterwards as an abscess or effusion is suspected, with the result that an ever-increasing proportion of lesions are being diagnosed with indisputable certainty. In recent years an attempt has been made to differentiate, by cultural meth-

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ods, between bovine and human infections, and up to the present time, no case of bovine tuberculosis has been discovered.

## GENERAL RULES OF TREATMENT

Immobilization of the patient and of the affected joints, for a length of time sufficient to permit apparent arrest of the disease as gauged by roentgenographic and clinical findings, and adequate care of any other foci of tuberculosis in the body, are recognized as essential. In a chronic systemic disease like tuberculosis, for which the only adequate treatment known at the present time is *rest*, any other attitude would appear to be short-sighted and productive of mediocre results when reviewed over a long period of time. It is customary to carry out a fusion operation in the weight-bearing joints, some months after the commencement of treatment, when the patient has shown clinical and laboratory evidence of a favorable response to recumbency. In the joints of the upper extremity, a fusion operation has been resorted to only when the patient has complained of pain or weakness in the joint after the arrest of the disease has been brought about by immobilization.

Under this general scheme of treatment, unless the patient declines to be operated upon, or unless he fails to respond to rest therapy, he ultimately undergoes a fusion operation, if the lesion is in the spine, hip, knee, ankle, or foot. The end results in these patients who have been operated upon have been very gratifying, but the rule of advising operation in all suitable cases renders impossible an accurate comparison of these results with those obtained by purely conservative methods in the smaller and less favorable group of patients who either refused operation, or who did not respond to simple immobilization therapy.

## FACTORS INFLUENCING PROGNOSIS

To obtain an accurate prognosis in bone and joint tuberculosis as a disease, it is necessary to analyze the results obtained in the entire group of 296 cases, irrespective of the therapeutic measures adopted. When this is done, it becomes apparent that there are several factors which influence the prognosis adversely, and of these, two are of outstanding importance,—namely, the presence of multiple foci of tuberculosis in the body, and the presence of organisms other than tubercle bacilli in any of these foci. The latter condition will be discussed first.

### 1. *Tuberculous Abscesses and Secondary Infection*

It has been observed, that uncontaminated tuberculous abscesses need not be a source of anxiety so long as the bone lesion is under adequate treatment by immobilization, because the abscess will subside with the regression of the bone lesion. It is the custom here to aspirate all abscesses, using a stringent aseptic technique, in order to relieve symptoms of pressure, to prevent spontaneous rupture through the skin, or simply to obtain material for confirmation of the diagnosis. An abscess is

aspirated at suitable intervals until pus can no longer be obtained. It has been observed that spontaneous bony fusion of a joint is more likely to occur if it is possible to remove by aspiration the pus and necrotic debris which lie between the two joint surfaces and impede the process of ankylosis.

It has also been observed that paraplegia may sometimes be relieved by aspiration of a paravertebral abscess in the thoracic region, a procedure which is most effectively carried out under fluoroscopic control. Abscesses which cannot be kept from perforating, are kept free from contamination after rupture by a moist antiseptic dressing (for example, Keith's dressing of carbolic in glycerine).

From time to time, however, patients are admitted with running sinuses, originating in bones and joints, already contaminated with staphylococcus, streptococcus, or other secondary organisms. The grave prognosis associated with such a complication, especially when it occurs in the spine, sacro-iliac joint, or hip, is too well known to require elaboration. Out of fifty-six cases of Pott's disease, free from tuberculosis elsewhere in the body, there was a mortality rate of 13 per cent. All the patients who died had secondary infections, and all save one, who died of a coronary occlusion, died as a direct result of their secondary infection. By the time they are admitted to the Hospital, many of these patients have suffered such degenerative changes from chronic suppuration, that they cannot tolerate treatment by drugs of the sulphonamide group. Even the encouraging results obtained in this Hospital from the use of sulphathiazole by mouth, combined with its direct application into sinuses, have only partially reduced the probability that a secondarily infected tuberculous bone or joint, unless it can be excised, will ultimately result in amyloidosis and death. This means that contaminated spine lesions in particular carry an exceedingly grave prognosis, because of the impossibility of excising or even saucerizing such lesions. It should perhaps be pointed out that the presence of secondary organisms at the mouth of a sinus does not necessarily mean invasion of the bone from which the sinus arises. It is the invasion of the bone which is catastrophic for the patient.

### 2. *Multiple Lesions of Tuberculosis*

One purpose of this report is to demonstrate that patients who have bone and joint lesions are the subjects of disseminated tuberculosis to a degree even greater than is generally suspected. Another purpose is to show to how great an extent this factor influences the prognosis for each individual. That this fact should be emphasized must be admitted, when it is recalled that surgeons still commonly fail to recognize the systemic nature of tuberculosis. There still exists the temptation to treat a tuberculous joint as a localized arthritis, and to overlook the fact that the skeletal lesion is an indication of invasion of the systemic blood stream by tubercle bacilli. On the other hand, recognition of this fact will lead automatically to a careful search for tuberculosis elsewhere in the body. In the group of 296 patients under consideration, tuberculosis was found

in the genito-urinary system in over 20 per cent., elsewhere in the skeleton in 28 per cent., and in the lungs (phthisis) in over 40 per cent. In the group of 59 per cent. showing no roentgenographic evidence of phthisis—active, arrested, or obsolescent—the bone lesions are doubtless the result of the chronic dissemination, through lymph channels and blood vessels, associated with a childhood primary lesion which remained active for a period of time, but ultimately healed. It is probable that the bone lesions in most of the remaining 40 per cent. also were laid down in a similar manner, but a few seem to have arisen late in the course of the disease, from an actively spreading phthisis which dominated the picture. The part played by trauma in adult life, in activating a bone lesion laid down many

TABLE I

INCIDENCE OF TUBERCULOUS COMPLICATIONS IN BONE AND JOINT TUBERCULOSIS
(356 Lesions in 296 Patients Discharged from Weston Sanatorium from 1931 through 1940)

| Site of Lesion | No. of Lesions | No Tbc. Comp. (*Per Cent.*) | Tuberculous Complications Single or Combined | | | Mortality Rate | |
|---|---|---|---|---|---|---|---|
| | | | Pulmonary (*Per Cent.*) | Skeletal (*Per Cent.*) | Genito-Urinary (*Per Cent.*) | No Tbc. Comp. (*Per Cent.*) | Entire Group (*Per Cent.*) |
| Spine | 173 | 32 | 37 | 37 | 27 | 13 | 29 |
| Hip joint | 51 | 59 | 18 | 26 | 20 | 23 | 31 |
| Sacro-iliac joint | 22 | 9 | 82 | 41 | 18 | 0 | 32 |
| Knee joint | 32 | 16 | 53 | 47 | 31 | 0 | 25 |
| Ankle and foot joints | 9 | 22 | 33 | 78 | 33 | 0 | 22 |
| Shoulder, elbow, wrist, and hand joints | 30 | 27 | 67 | 40 | 20 | 0 | 43 |
| Clavicle, scapula, os innominatum, femur, tibia, fibula | 11 | 9 | 64 | 73 | 27 | 0 | 36 |
| Tendon sheaths, bursae, soft-tissue abscesses | 28 | 7 | 68 | 57 | 25 | 0 | 39 |
| Total lesions | 356 | 30 | 44 | 40 | 25 | | |
| Number of individual patients represented | 296 | 106 | 123 | 85 | 68 | 14 | 85 |
| Percentage of entire group of 296 | 100 | 35.8 | 41.6 | 28.6 | 23.0 | 13.2 (of 106) | 28.6 |

years ago in childhood, offers food for considerable thought and speculation.

### INCIDENCE OF TUBERCULOUS COMPLICATIONS IN SKELETAL TUBERCULOSIS

At this juncture it will be worth while to emphasize the high incidence of multiple foci of tuberculosis in patients with bone and joint lesions. Accordingly, an analysis of 356 lesions occurring in 296 patients is presented in tabular form. It must be kept in mind that only 296 individuals are represented, although 356 separate lesions are analyzed. The figures at the foot of the table give the incidence in the 296 patients; while the figures opposite each joint give the incidence in all patients having a lesion in that joint.

The lesions chosen for study are the three commonest tuberculous complications of patients who have a tuberculous bone or joint,—namely pulmonary tuberculosis, other tuberculous bones or joints, and genito-urinary tuberculosis. Many patients have all three complications; hence the overlapping of figures in Table I. While some of the groups are too small to have any significance, the larger groups and the totals should have some value. The following points are presented as being of special interest.

1. *Cases without Demonstrable Tuberculous Complications* (35.8 per cent.)

More than one-third of all patients had an isolated lesion of skeletal tuberculosis. No explanation is offered for the comparative freedom of patients with hip-joint lesions from complications (59 per cent.), nor for the rarity of uncomplicated sacro-iliac lesions (9 per cent.). However, attention should be drawn to the frequency with which the latter are associated with phthisis (82 per cent.). The actual mortality rates for the two groups, strangely enough, are practically the same (31 and 32 per cent.), but this is due to the fact that over one-third of the fatalities in patients with hip lesions came from non-tuberculous disease.

2. *Cases Complicated by Pulmonary Tuberculosis* (41.6 per cent.)

Pulmonary tuberculosis is the commonest and most serious of all tuberculous complications of bone and joint lesions. One is impressed by the folly of undertaking to treat a joint lesion in a general hospital without even having a chest roentgenogram made; and yet this used to be a not infrequent procedure. This analysis again places the hip joint in a favorable light, as phthisis (active or arrested) was present in only 18 per cent. of fifty-one cases, as compared with a general incidence of 41 per cent., and an incidence of 82 per cent. of twenty-two patients with sacro-iliac lesions. Pulmonary disease was classified as minimal in 37 per cent., moderately advanced in 36 per cent., and far advanced in 27 per cent. The effect of an active pulmonary lesion on the prognosis will be considered later.

TABLE II

IMMEDIATE CAUSES OF DEATH IN BONE AND JOINT TUBERCULOSIS
(85 Deaths in 296 Discharged Patients)

| | No. of Cases | Percentage of Discharges | Percentage of Deaths |
|---|---|---|---|
| Miliary tuberculosis and tuberculous meningitis | 27 | 9.1 | 31.7 |
| Pulmonary tuberculosis | 22 | 7.4 | 25.9 |
| Chronic suppuration in bone tuberculosis (11 with amyloidosis and 5 without amyloidosis) | 16 | 5.4 | 18.8 |
| Addison's disease | 6 | 2.0 | 7.1 |
| Renal tuberculosis | 3 | 1.0 | 3.5 |
| Non-tuberculous deaths (including 2 cases of postoperative embolism) | 11 | 3.7 | 13.0 |
| Totals | 85 | 28.6 | 100.0 |

3. *Cases with More Than One Focus of Bone Tuberculosis* (28.6 per cent.)

This complication may prolong treatment considerably, as well as impair the prospects of the patient's return to work. More than three-fourths of the patients with tuberculosis in the ankle and foot fell into this group, while only about one-fourth of those with hip lesions were subject to this complication.

4. *Cases Complicated by Tuberculosis of the Genito-Urinary System* (23.0 per cent.)

This complication occurs with considerably greater frequency in patients suffering from multiple bone lesions than in those with a single bone lesion, indicating a wide dissemination of infection following the primary invasion in childhood. In cases of pulmonary tuberculosis without skeletal involvement, the incidence is only 1.75 per cent. The presence of genito-urinary tuberculosis appears to affect the prognosis less seriously than does the presence of pulmonary tuberculosis, or of multiple bone lesions, being a less incapacitating disease. It is of interest to observe that the incidence of genito-urinary tuberculosis varies but little from group to group. Perhaps this is due to the greater certainty with which this complication can be diagnosed by a persistent routine of periodic culture of the urine for tubercle bacilli in all cases of bone and joint tuberculosis.

## THE EFFECT OF TUBERCULOUS COMPLICATIONS ON PROGNOSIS

1. *Mortality* (Tables I, II, and III)

The general mortality rate in the group of 296 patients was 28.6 per cent. As generalized miliary tuberculosis and meningitis are so often

TABLE III

MORTALITY RATE AND CAUSE OF DEATH, GROUPED ACCORDING TO MULTIPLICITY OF LESIONS

| Tuberculous Complications of Bone and Joint Lesions | No. of Patients | No. of Deaths | Mortality (*Per Cent.*) | Immediate Cause of Death (*No. of Cases*) | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Meningitis and Miliary Tuberculosis | Pulmonary Tuberculosis | Chronic Suppuration | Addison's Disease | Renal Tuberculosis | Non-Tuberculous Disease |
| 1. Single bone and joint lesion | 106 | 14 | 13.2 | 2 | — | 8 | — | — | 4 |
| 2. Single bone and joint lesion plus genito-urinary tuberculosis | 24 | 4 | 17 | — | — | 1 | 1 | — | 2 |
| Multiple bone and joint lesions | 29 | 6 | 21 | 3 | — | 1 | 1 | — | 1 |
| Multiple bone and joint lesions plus genito-urinary tuberculosis | 14 | 3 | 21 | — | — | 1 | 1 | — | 1 |
| Total of 2 | 67 | 13 | 19.4 | 3 | — | 3 | 3 | — | 4 |
| 3. Single bone and joint lesion plus pulmonary tuberculosis | 66 | 25 | 38 | 11 | 10 | 2 | — | — | 2 |
| Multiple bone and joint lesions plus pulmonary tuberculosis | 27 | 12 | 44 | 3 | 5 | 2 | 1 | — | 1 |
| Single bone and joint lesion plus pulmonary plus genito-urinary tuberculosis | 15 | 12 | 80 | 6 | 4 | — | 1 | 1 | — |
| Multiple bone and joint lesions plus pulmonary plus genito-urinary tuberculosis | 15 | 9 | 60 | 2 | 3 | 1 | 1 | 2 | — |
| Total of 3 | 123 | 58 | 47.1 | 22 | 22 | 5 | 3 | 3 | 3 |
| Total of 1, 2, and 3 | 296 | 85 | 28.6 | 27 | 22 | 16 | 6 | 3 | 11 |

found in conjunction, they have been grouped together in Table II. This was the immediate cause of death in 9 per cent. of the patients, and thus accounts for nearly one-third of the fatalities,—an incidence much higher than that found in patients with pulmonary tuberculosis without systemic involvement, of whom only 2 to 3 per cent. die from this complication.

Pulmonary tuberculosis was the immediate cause of death in 7.4 per cent. of the patients, and thus accounts for about one-quarter of all deaths. Bone tuberculosis, or chronic suppuration, nearly always due to secondary infection, and usually ending in amyloidosis, caused death in 5.4 per cent. of the patients, thus accounting for almost one-fifth of all deaths. Adrenal tuberculosis was the immediate factor in 2 per cent., and thus exceeds renal tuberculosis (1 per cent.) in importance as a cause of death. Of the three chronic tuberculous complications considered, pulmonary tuberculosis is thus the most serious, bone tuberculosis with suppuration the next, and renal tuberculosis the least frequently fatal.

Non-tuberculous disease resulted in death in 3.7 per cent. of the patients, the commonest cause being coronary occlusion (three cases). Other causes were glomerular nephritis (two), postoperative embolism (two), pericarditis, lobar pneumonia, influenzal pneumonia, and acute pulmonary oedema (one each).

A glance at the last two columns in Table I will show that only fourteen deaths occurred among the 106 patients whose bone and joint lesions were not complicated by tuberculosis elsewhere, a mortality rate of 13.2 per cent. This leaves seventy-one deaths among the 190 patients who had multiple foci, a rate of 37.4 per cent. In the former group the deaths were all of patients with spinal or hip-joint tuberculosis, and more than half of them were due to chronic suppuration, again emphasizing the gravity of secondary infection of bone. These patients would almost certainly have been living today if their abscesses had been treated by aspiration, instead of by incision without adequate antiseptic aftercare.

The rise in the mortality rate, which accompanies the increase in the number of tuberculous foci in a patient, is shown in Table III. The 13 per cent. mortality associated with the single-focus group, rises to between 17 per cent. and 21 per cent. when genito-urinary tuberculosis or when multiple bone foci are added. When pulmonary tuberculosis enters the picture the rate is greatly increased, ranging from 38 per cent. in the most favorable group, to between 60 per cent. and 80 per cent. when genito-urinary and multiple bone foci are present. The pulmonary disease is often more advanced in these latter groups.

The causes for this mortality are shown in the second part of Table III. In the single-lesion group, 86 per cent. of the deaths were due to either chronic suppuration or non-tuberculous disease. In the group with complications but without pulmonary tuberculosis, the immediate cause of death was found to be secondary infection, or non-tuberculous disease slightly more often than tuberculous meningitis or Addison's

disease, indicating that many of these patients survive their tuberculous infection and die of something else. Addison's disease caused as many deaths as chronic suppuration and meningitis or miliary tuberculosis. Renal tuberculosis was not a direct cause of death.

In the group of patients with the complication of pulmonary tuberculosis, the lung focus caused as many deaths as miliary tuberculosis and meningitis, and these two causes of death accounted for three-fourths of the total. The remaining fourth was divided almost evenly between chronic suppuration, Addison's disease, renal tuberculosis (uraemia), and non-tuberculous disease.

The extremely adverse effect of pulmonary tuberculosis should serve as an incentive to search for this complication and to treat it vigorously from the very beginning, rather than to devote so much attention to the joint lesion that the pulmonary one receives scant care.

It is very obvious that meningitis and miliary tuberculosis increase rapidly in incidence with increase in the number of lesions, occurring in less than 2 per cent. of those with a single focus, in less than 5 per cent. of those with non-pulmonary multiple foci, and in 18 per cent. of those with both pulmonary tuberculosis and multiple systemic lesions.

Miliary tuberculosis was not precipitated by surgery in any of these patients, so far as could be ascertained. In one case, it is true, meningitis appeared three weeks after an arthrodesis of the hip joint, but a post-mortem examination of the brain revealed the presence of old tubercles, and miliary tubercles were not found elsewhere in the body. The only other case of meningitis to occur within a year of operation, was in a patient with advanced pulmonary and laryngeal tuberculosis, and his operation was on the spine, so that the actual site of the disease was not disturbed by surgery.

Bone suppuration caused death to approximately the same degree (about 4 per cent.) in both groups with multiple foci, but was nearly twice as frequent a cause of death (7.5 per cent.) in the group without complications, presumably because these patients had, so to speak, a smaller choice of lesions from which to die. How many lives might have been saved if chronic suppuration had been prevented by adequate treatment of abscesses!

2. *Suitability for Operation, Arrest of Disease, and Capacity for Work* (Table IV)

The large group of 173 cases of Pott's disease, when examined in detail, throws considerable light on the effect which multiple foci of tuberculosis in the body have upon the chances of the patient undergoing surgery, of having tuberculosis throughout the body arrested, and of returning to work. The important lesson to be learned from Table IV is that the chance of arresting tuberculosis in the body decreases with the number of systems affected, while the mortality rate rises. It is axiomatic, of course, that the incidence of ability to return to work increases directly

TABLE IV

PROGNOSIS OF POTT'S DISEASE (1 to 10 Years)

Analysis of Multiple Lesions of Tuberculosis in 173 Patients *
Followed at Toronto Hospital for Treatment of Tuberculosis, 1931 through 1940

| Tuberculous Lesions Combined in One Patient | No. of Patients | Bone-Graft Operation (*Per Cent.*) | All Lesions Arrested (*Per Cent.*) | Died (*Per Cent.*) | Now Working | | |
|---|---|---|---|---|---|---|---|
| | | | | | Full Time (*Per Cent.*) | Part Time (*Per Cent.*) | Total (*Per Cent.*) |
| Spine (isolated lesion) | 56 | 82 | 80 | 13 | 61 | 16 | 77 |
| Spine plus pulmonary lesion | 28 | 64 | 50 | 32 | 27 | 15 | 42 |
| Spine plus other bone lesion | 24 | 46 | 38 | 25 | 21 | 17 | 38 |
| Spine plus genito-urinary lesion | 17 | 76 | 35 | 20 | 17 | — | 17 |
| Spine plus combined bone and genito-urinary lesions | 12 | 58 | 25 | 17 | 17 | — | 17 |
| Spine plus combined pulmonary and bone lesions | 17 | 30 | 12 | 53 | 6 | 6 | 12 |
| Spine plus combined pulmonary and genito-urinary lesions | 8 | 38 | 13 | 75 | 13 | — | 13 |
| Spine plus combined pulmonary, bone, and genito-urinary lesions | 11 | 36 | 18 | 64 | 9 | — | 9 |
| Total | 173 | 60.1 | 46.8 | 28.6 | 31.2 | 11.0 | 42.2 |

* All percentages are based on total number of patients in each group.

with the rate of cure, which in turn varies inversely with the number of lesions.

*Single Lesion* (56 patients). In this group, free from tuberculosis elsewhere in the body, 82 per cent. of the patients with Pott's disease were good operative risks, and in 80 per cent. complete arrest of the disease was achieved. As previously noted, of the 13 per cent. who died, all save one died as a direct result of secondary infection of a cold abscess. At present, 77 per cent. of the fifty-six patients in this group are working, most of them full time, a rate almost double that prevailing (42 per cent.) in the total group of 173 patients with spine lesions.

*Pulmonary Lesion* (64 patients). Without going into a detailed consideration of the extent of the pulmonary lesion, it is sufficient to say that the presence of pulmonary tuberculosis by itself, even without other tuberculous complications, promptly reduces the operability of the patient by 18 per cent., reduces the cures from 80 per cent. to 50 per cent., increases the death rate from 13 to 32 per cent., and reduces the expectation of return to work from 77 per cent. to 42 per cent. If the pulmonary lesion is associated with other systemic lesions, the chances for healing drop to between 12 per cent. and 18 per cent., the mortality rate rises rapidly to between 53 per cent. and 75 per cent., while the incidence of return to work dwindles to 9 per cent. to 12 per cent.

*Bone or Genito-Urinary Lesions* (53 cases without and 36 cases with pulmonary lesions). Similarly, the occurrence of either multiple bone lesions, or of genito-urinary tuberculosis, or of both, lowers the expectation of cure, and of a return to work, though not so much as when pulmonary tuberculosis is combined with these lesions. Genito-urinary tuberculosis affects the mortality less than multiple foci in bones. When a patient with Pott's disease has pulmonary and genito-urinary tuberculosis, and multiple bone lesions, his hospitalization must last longer to allow for adequate treatment of each lesion, but his expectation of obtaining arrest of disease in the body is only 18 per cent., and his chance of returning to work, only 9 per cent. In spite of this, bone-grafting of the spine was carried out in 36 per cent., in an endeavor to save the patient from a bed-ridden existence; and occasionally brilliant results were unexpectedly obtained, with permanent healing of all lesions. None of these cases should be abandoned as hopeless, but treatment should be undertaken with the expectation of salvaging a small, but appreciable number.

A similar analysis of the fifty-one patients with hip-joint tuberculosis shows a comparable state of affairs, with 57 per cent. operated on, and 57 per cent. obtaining arrest of tuberculosis in the body in the group without complications, as compared with 50 per cent. operated on and 47 per cent. obtaining arrest in the total group. The mortality rate for the latter was 31 per cent., and 47 per cent. are now working, as compared with a mortality of 28 per cent., and a return to work of 42 per cent. in the entire group with Pott's disease.

In knee-joint tuberculosis the difference in prognosis for those with a

TABLE V

SPINE BONE-GRAFTING FOR POTT'S DISEASE

End Results in the First 100 Consecutive Patients Followed at the Toronto Hospital for the Treatment of Tuberculosis, 1931 through 1940

| | | | |
|---|---|---|---|
| Pott's Disease Arrested | | | 88 per cent. |
| Patients working full time | | 50 | |
| No evidence of active tuberculosis in the body | 46 | | |
| Required subsequent operation for hip | 1 | | |
| Evidence of quiescent tuberculosis of lung or knee | 2 | | |
| Required subsequent grafting for new lesions | 1 | | |
| Working part time | | 14 | |
| No evidence of active tuberculosis in body | 12 | | |
| Required second hospitalization | 2 | | |
| Unemployed because of | | 9 | |
| Recent discharge from Hospital | 6 | | |
| Disability from healed pulmonary tuberculosis | 2 | | |
| Disability from unstable tuberculous hip | 1 | | |
| Still require hospital treatment, for | | 8 | |
| Tuberculosis of hip | 3 | | |
| Tuberculosis of other bones or joints | 3 | | |
| Renal tuberculosis or persistent paraplegia | 2 | | |
| Died after discharge from Hospital | | 7 | |
| Miliary tuberculosis and meningitis | 1 | | |
| Pulmonary tuberculosis | 1 | | |
| Renal tuberculosis | 1 | | |
| Addison's disease | 2 | | |
| Non-tuberculous pulmonary disease | 2 | | |
| Pott's Disease Not Arrested | | | 12 per cent. |
| Due to spine fusion in unstable position | | 2 | |
| Recurrence in or adjacent to original site | | 5 | |
| Death during treatment | | 5 | |
| Secondary infection of spine after operation followed by amyloidosis | 1 | | |
| Addison's disease | 1 | | |
| Miliary tuberculosis and meningitis | 3 | | |

single lesion, and those with tuberculous complications is even greater. One hundred per cent. of the patients without complications are now working, while in the entire group of thirty-two patients only 44 per cent. are back at work, the difference being due to the disabling effects of some types of tuberculous complications.

3. *Effect of Tuberculous Complications in Cases of Bone Graft* (Table V)

Finally, the effect of tuberculous complications on the prognosis for patients whose condition has been good enough to permit a bone-graft operation on the spine, is illustrated in Table V, which shows the end result in the first 100 consecutive patients who have been discharged and followed for one to ten years, and whose condition at the present time has been ascertained by examination.

The 100 cases include nearly all the patients without complications, and many of those with various tuberculous complications. Pott's

disease was arrested in eighty-eight, but only sixty-four of the 100 are now working, and a careful inspection of Table V shows that even among those now working, recovery was delayed in six by multiple lesions. Twenty-four of the eighty-eight patients with arrested Pott's disease are not working. Among these, nine are living at home and three of them have no prospect of becoming employed, because of tuberculosis elsewhere. Eight others still require hospital treatment for tuberculosis elsewhere, although their Pott's disease has been arrested. Seven died after being discharged as cases of arrested Pott's disease, five of them from tuberculosis elsewhere in the body. In four of the twelve whose tuberculosis of the spine was not arrested, the unfavorable result was due to tuberculosis elsewhere. Thus, even in this selected group of 100 cases of bone-grafting, a favorable outcome was delayed or prevented in twenty-six by the presence of tuberculous complications.

It would, however, be unfortunate to leave the impression that it is not worth while spending time on patients suffering from multiple foci of tuberculosis. If all lesions are treated individually and vigorously, and if the patient is kept at adequate rest, the results in many cases will be astonishingly good, and often of long duration and perhaps permanent. The results obtained by surgical ankylosis of the involved joints have been very impressive; bony fusion is promoted in this way more certainly and usually more quickly than by immobilization without surgery. The fibrous ankylosis, which is often the best result to be hoped for without surgery, rarely gives a patient the same sense of security and of ability to undertake hard work, as does bony ankylosis. Surgery also either entirely removes, or permanently and completely immobilizes a lesion which would otherwise be only a quiescent and unprotected one. Surgery can be carried out with safety after control of the pulmonary lesion has been secured by any of the numerous methods at the disposal of phthisiologists and thoracic surgeons today, and the desired ankylosis of bone obtained with a greater degree of certainty if the surgery is delayed until all tuberculosis throughout the individual is under control.

## CONCLUSIONS

1. Bovine tuberculosis is no longer a factor of any significance in the causation of bone and joint tuberculosis among adults in Ontario.
2. Adequate treatment of bone and joint tuberculosis demands adequate provision for rest as well as adequate provision for surgery.
3. Prognosis is affected favorably by two factors in particular:
   (a) Adequate treatment of abscesses, so as to prevent secondary infection of bone,—the existence of an uncontaminated tuberculous abscess need not affect the prognosis adversely.
   (b) Freedom from multiple lesions of tuberculosis in the body.
4. Secondary infection of various joints has the following effects:
   (a) Of the spine renders the prognosis almost hopeless;
   (b) Of the sacro-iliac joint and hip renders the prognosis poor;

(c) Of the knee, ankle, or foot requires excision or amputation;
(d) Of the joints of the upper extremity greatly prolongs hospitalization.

5. Multiple lesions of tuberculosis are to be found in a high proportion of cases, as follows:

(a) Pulmonary tuberculosis in over 40 per cent.
(b) Multiple bone tuberculosis in almost 30 per cent.
(c) Genito-urinary tuberculosis in over 20 per cent.

The prognosis is affected adversely by the presence of these complications, their importance being in the order named.

6. More than one-third of all patients were free from multiple tuberculous foci. The percentage of arrested disease and the ability to return to work in these patients was high, especially in the cases of tuberculosis of the spine (80 per cent.) and of the knee (100 per cent.). The mortality rate was 13 per cent. and was usually due to secondary infection of bone, or to non-tuberculous disease.

7. Almost one-quarter of all patients had additional tuberculosis in other bones, or in the genito-urinary system, or in both, but not in the lungs. In these, the treatment has to be long enough to arrest tuberculosis throughout the body, and more than one operation is usually required. The incidence of return to work is much reduced and the mortality rate rises to about 20 per cent., due to the appearance of meningitis and of Addison's disease in addition to chronic suppuration and non-tuberculous disease.

8. Over 40 per cent. of all patients had pulmonary tuberculosis, the most serious of tuberculous complications. When this is combined with other skeletal and renal foci the prognosis is very much worse than when pulmonary tuberculosis is the only complication, the incidence of arrested disease and of return to work in the latter being between 40 and 50 per cent., and in the former between 12 and 20 per cent. The mortality rate rises from 38 per cent. in the latter to between 44 and 80 per cent. in the former, the outstanding causes being miliary tuberculosis, meningitis, and pulmonary tuberculosis.

9. Tuberculosis of the spine was arrested in 88 per cent. of patients treated by spine bone graft, but in 26 per cent. the arrest of the systemic disease was delayed or entirely prevented by tuberculosis elsewhere in the body.

10. The best results are to be obtained by treating bone and joint tuberculosis first by rest and by controlling other tuberculous foci in the body; then by operation to secure bony ankylosis of the affected joint, because the results following this are superior to those obtained by the fibrous ankylosis or unstable joints which so often mark the end result of non-surgical treatment.

# HIP-JOINT INVOLVEMENT IN GAUCHER'S DISEASE

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Gaucher's disease was first described in 1882 by the man who gave his name to the condition. He thought it was a neoplasm. Subsequently, it was found to be a rare, familial disorder of lipoid metabolism, characterized by the deposition of kerasin in the reticulum cells of the reticulo-endothelial system. These cells take on a typical appearance, and are called Gaucher cells. The disease is largely, though not entirely, confined to Jewish patients. Symptoms occur most often in childhood and adolescence, but, because of its chronicity and slow progression, its victims may live a fairly normal life for many years. In several of the authors' cases, the diagnosis was not established until well on in adult life.

Any part of the reticulo-endothelial system may be involved, but the spleen, liver, lymph nodes, and bone marrow are most commonly affected. The bone changes were first described from the gross pathological viewpoint comparatively recently (1922) by Pick. In 1926, Cushing and Stout reported a woman, thirty-three years old, who complained of pain and stiffness of one hip. Roentgenograms showed marked collapse of the acetabulum and upper end of the femur. Bone sections, removed at operation, showed the typical infiltration of bone trabeculae by Gaucher cells. This was the first reported case with roentgenographic evidence of bone or joint involvement, and the only one in the entire literature on Gaucher's disease in which surgery was done in the hip. Several other patients with involvement of the long bones have had operations after a diagnosis of osteomyelitis.

Welt, Rosenthal, and Oppenheimer in 1929, and Reiss and Kato in 1932, discussed the bone lesions of this disease in detail, and reviewed the literature preceding their papers. In three out of the six cases reported by the former, hip-joint changes had occurred. The latter stressed the hip-joint changes in their cases and in others taken from the literature. Since 1932, additional cases with evidence of hip-joint involvement have been reported by Pachman; Melamed and Chester; Bloem, Groen, and Postma; de Lange; and Determann. In all, sixteen cases with roentgenographic evidence of hip-joint involvement have been reported in the literature.

It is the purpose of this paper to review and attempt to classify these bone changes as they involve the hip joint, and to add eight additional cases. All the skeletal changes are attributable to the infiltration and replacement of the bone trabeculae by kerasin-bearing, reticulum cells. These lesions appear on roentgenograms as translucent or more radiotransparent areas, and account for the characteristic mottling. The

* Services of Robert K. Lippman, M.D., and the late Seth Selig, M.D.

fusiform expansion of the lower femur with thinning of the cortex was first described by Welt, Rosenthal, and Oppenheimer as typical of Gaucher's disease.

Under the influence of weight-bearing, several changes, besides the infiltration and mottling, may appear. Collapse and aseptic necrosis of the femoral head with absorption of the acetabulum[3] may be noted. Infiltration and thickening of the neck of the femur with coxa vara formation have been described by several investigators. In children, the resemblance of this lesion to chronic osteomyelitis, tuberculous coxitis, and Legg-Perthes disease has been noted by Reiss and Kato. These observers also mention the occurrence of pathological fracture in the neck of the femur, as well as in other long bones. Late osteo-arthritic manifestations appear in the case reported by Determann.

The authors present eight cases of Gaucher's disease with various types of hip-joint involvement. At the Mount Sinai Hospital, on the ward services, from 1933 to 1941, the diagnosis of Gaucher's disease was verified in nineteen cases. All but one of the patients with hip lesions were taken from this group. The patient in Case 6 is from the practice of the late Seth Selig, M.D., and is the brother of the patient in Case 4. Eight out of twenty, or 40 per cent. of the patients had hip lesions. This is second in frequency only to changes in the lower femoral shaft, the latter occurring in about two-thirds of the cases. The authors' cases (as well as those from the literature) have been classified into the following groups:

A. *Hip Lesions in Children*

1. Lesions of the femoral head, usually suggesting Legg-Perthes disease or early tuberculous coxitis (Cases 1 and 2);
2. Lesions of the femoral neck (Case 3) with:
   a. Simple infiltrative roentgenographic changes,
   b. Pathological fracture of the neck,
   c. Coxa vara deformity, with broadening and irregularity of the epiphyseal line, suggesting epiphysiolysis, which might be secondary to simple infiltrative changes or pathological fractures of the neck.

B. *Hip Lesions in Adults*

1. Osteo-arthritic symptoms and signs, probably secondary to childhood lesions of any of the above types (Cases 4, 5, and 6);
2. Roentgenographic evidence of similar changes in patients with Gaucher's disease, usually in young adults, but without any symptoms or signs pointing to the hip. It is likely that, in time, this group may develop symptoms of osteo-arthritis (Cases 7 and 8).

Although the onset is often associated with intermittent pain in various bones and joints, and low-grade fever, the diagnosis can be made only by recognizing the underlying Gaucher's disease, as well as the local condition. The presence of splenomegalia, hepatomegalia, secondary

FIG. 1-A

Case 1. M. D. May 9, 1940. Perthes-like changes in the left hip.

FIG. 1-B

Case 1. M. D. May 9, 1940. Infiltration and expansion of lower femora.

FIG. 1-C

Case 1. M. D. September 14, 1941. Regeneration of capital epiphysis (Compare with Fig. 1-A).

anaemia, often with slight leukopenia and thrombocytopenia, hemorrhages, and brown pigmentation of the skin, is of importance. Once the disease is suspected, it can nearly always be confirmed or ruled out by the relatively simple procedure of puncture of the sternal bone marrow. The pathologist can easily identify the large typical cells in the aspirated material. The finding of these cells confirms the diagnosis. Aspiration of the spleen and splenectomy are both unnecessary. Roentgenographic changes in the lower femora are also typical.

The disease in general, as well as its bone lesions, is chronic, lasting for many years. Symptoms may occur at intervals, but there are often free periods in spite of persistent pathology. Very little can be found in the literature about the therapy of skeletal manifestations of Gaucher's disease. For the orthopaedic aspect, the authors have treated their patients with some form of rest during periods of acute symptoms, and in children, for a prolonged period thereafter. Depending on the severity of the disease, simple bed rest, traction, or immobilization in a hip spica may be indicated. Especially in childhood, prolonged rest is considered indicated, as it is in coxa plana, to minimize deformity in what is apparently a vulnerable period of hip-joint growth. While the follow-up period is hardly adequate to prove the benefit of such immobilization, in Cases 1 and 3 definite healing appears to have taken place. In the

former, regeneration of an approximately normal femoral head appears to be taking place as in Legg-Perthes disease, while in the latter, a pathological fracture healed with excellent restoration of bone structure, although with some coxa vara deformity. Both cases are still under treatment by rest, so that the final result is not yet evident.

It is known that the more the structure of a hip deviates from the normal, the more likely is the early onset of osteo-arthritis, which may ultimately become very severe. Once this has developed, disability is inevitable. Cushing and Stout have reported the only instance of surgical therapy in a Gaucher hip joint. This patient, a woman, thirty-three years old, had a resection of the femoral head and neck, and removal of six loose "sequestra" from the partly destroyed acetabular wall. In spite of her anaemia, she made an uneventful recovery from the operation, although there was no long follow-up. In at least one of the authors' cases (Case 5) surgery on the hip joint was seriously contemplated. Hematological study revealed leukopenia and thrombocytopenia. It was then thought that arthrodesis, which was the operation of choice, was unlikely to succeed and that hemorrhagic complications were likely. Apart from surgery, physiotherapy and roentgen therapy have proved ineffective. Rest in recumbency, with traction, has given at least temporary relief in adults and children alike.

## REPORT OF CASES

### A. *Hip Lesions in Children*

CASE 1. M.D. (Hospital No. 447461), a German-Jewish girl, was ten years of age when admitted to the Mount Sinai Hospital on October 18, 1939. She complained of pain in the left knee and hip of six weeks' duration. A similar attack had occurred one year before and was associated with low fever and a limp. It had been called "periostitis" in Germany where she then was, and she had recovered in two weeks.

Examination showed tenderness of the left knee, restriction of motion of the left hip in all directions, enlarged liver and spleen, and normal temperature.

A puncture of the sternal-bone marrow had been done in the Out-Patient Department, and Gaucher cells were found. Roentgenographic examination (Figs. 1-A and 1-B) of the femora showed irregular areas of rarefaction in the medullary cavity of the left femur in its lower half, and a distinct tendency toward clubbing of the lower ends of both femora. There was a marked deformity of outline.

A sister also had a positive sternal marrow loaded with Gaucher cells, but showed no bone lesions either clinically or by roentgenogram.

The course of this case thus far has resembled very much Legg-Perthes disease of the hip. She improved rapidly with bed rest. A caliper brace was fitted to relieve weight-bearing as much as possible. Roentgenographic examination in September 1941 showed definite, though partial, restitution of the structure and appearance of the head. Some deformity of a coxa plana type persisted (Fig. 1-C). She has been kept at partial or complete rest up to date in the Blythedale Home and Hospital for Convalescent Crippled Children. As relatively normal appearance of the head is noted, full weight-bearing will be allowed.

CASE 2. M. S. (Hospital No. 448304), a German-Jewish girl was ten years old when first seen at the Mount Sinai Hospital on November 25, 1939, with a complaint of pain in the left thigh on walking, of three months' duration. She was first seen at another hospital on October 1, 1938, for limp and pain in the right knee and thigh. Roentgenographic examination of the femora at that time was said to be negative, but spleno-

FIG. 2

Case 2. M. S. November 2, 1939. Infiltration of left femoral head.

megalia had been noted. Symptoms subsided with bed rest. In a subsequent admission in April 1939, the diagnosis of Gaucher's disease had been established by splenic puncture, and splenectomy had been done.

On admission to Mount Sinai, tenderness and slight restriction of motion of the left hip was noted. Roentgenographic examination showed an infiltration with mottling of the upper portion of the left femoral head, like an atypical Legg-Perthes disease (Fig. 2). An eosinophilia of 7 per cent. was also noted.

Pain promptly disappeared with bed rest. A caliper brace was suggested, but before it could be obtained, recovery was so complete that it was omitted. Reexamination four months later revealed no further symptoms or signs related to the bones, and an excellent general condition. She then moved out of town so that further follow-up was impossible.

CASE 3. E. K. (Hospital No. 472130), a Jewish boy had a series of admissions to the Mount Sinai Hospital, beginning in February 1938, at the age of five. His presenting symptom was pain in the lower part of the right femur following a fall. Similar pain had previously been present without injury.

On admission, his temperature was elevated to 101 degrees. There was some restriction of motion in the right knee and tenderness over the lower femur. An enlarged spleen and eosinophilia of 10 per cent. were present, but the diagnosis was not made. Roentgenographic examination was negative. Prompt recovery occurred with bed rest.

He was readmitted in September 1938 for restudy. The liver and spleen were now both enlarged. A sternal puncture revealed typical Gaucher cells in the bone marrow. Roentgenographic examination of the skull and femora showed no changes. In December 1938, he developed a limp in his right lower extremity, with pain on walking, and with no known injury. Roentgenographic study at that time showed a pathological infraction of the neck of the right femur with coxa vara deformity (Fig. 3-A.) There was

FIG. 3-A

Case 3. E. K. December 28, 1938. Pathological fracture of right femoral neck.

also medullary mottling at the lower ends of both femora. Symptoms of pain in the hip and both knees continued intermittently until he was readmitted in December 1940. At that time the only additional findings were an increased phosphatase, 37 King-Armstrong units, and a persistent eosinophilia. Roentgenograms showed some progression of the lesions of the bones.

In April 1941, he was again admitted for pain in the right hip and inability to walk, of one week's duration. There was again an elevated temperature (102 degrees), marked spasm of the right-hip muscles, and tenderness over the anterior and lateral aspect of the joint. An inflammatory lesion was suspected in addition to Gaucher's disease. Roentgenographic examination showed marked coxa vara, but the epiphysis of the femoral head was undisturbed. Atrophy of the right pelvic bones was present (Fig. 3-B). Traction was applied and brought prompt relief of pain. The temperature gradually became normal. He was discharged to the Blythedale Home and Hospital for Convalescent Crippled Children for a further period of rest and limited weight-bearing. While there, it was deemed advisable to apply a hip spica for further immobilization.

FIG. 3-B

Case 3. E. K. April 21, 1941. Healed pathological fracture with coxa vara.

The final admission to Mount Sinai was in September 1941. Roentgenographic study at this time showed the same diffuse bone changes previously observed, and typical of Gaucher's disease. Persistent coxa vara was present, but there was no sign of the previous femoral neck infraction, and there was no epiphyseal change. Gradual mobilization and weight-bearing were then instituted.

B. *Hip Lesions in Adults.*

CASE 4. A. R. (Out-Patient No. 40–5471), a woman, thirty-two years old, and a deaf mute, came to the Dispensary complaining of pain in the left hip. There was a history of splenomegalia treated at another hospital. In May 1939, splenectomy had been done, and the pathological diagnosis of Gaucher's disease was made. Her hip symptoms were rather mild, and caused little interference with activity. A limp had been present since childhood, but the hip pain was said to be of a few months' duration. At the age of ten, she had had a plaster cast on the right hip for a period of two and one-half years for "Legg-Perthes" disease.

She limped on the right lower extremity, and motions of the right hip were all somewhat restricted. There was no shortening, but one inch of atrophy of the right thigh was present.

Roentgenographic examination in September 1940 (Fig. 4) showed a mushroom deformity of the head of the right femur with coxa vara deformity. The femoral neck was shortened and widened. Both the femoral head and the acetabulum were irregular, and there was a marked coarsening of the trabecular structure in the upper end of both femora. Roentgenograms of the long bones showed areas of rarefaction up to one and

FIG. 4

Case 4. A. R. September 11, 1940. Deformity of left hip with mild symptoms in an adult.

five-tenths centimeters in diameter in both shafts of the femora, tibiae, and humeri. There was general decalcification of all the bones, and clubbing of the lower ends of both femora. While the hip changes resembled osteo-arthritis superimposed on an old condition of coxa plana, they were considered typical of Gaucher's disease in the bones.

CASE 5. F. K. (Hospital No. 447741), a Jewish woman, was thirty-two years of age when first treated at the Mount Sinai Hospital in 1929. At that time she complained of pain in the left thigh of four years' duration, as well as of frequent nosebleeds.

Physical findings at that time included splenomegalia, bilateral pingueculae, and hepatomegalia. There was restriction of motion of the left hip and shortening of one and one-half inches in the left lower extremity.

Roentgenographic examination revealed expansion of the lower portion of the shaft of the femora with thinning of the cortex. There was marked irregularity and absorption of the head and neck of the left femur (Fig. 5).

Since that time, the patient has had more or less constant pain in the left hip, severe enough to cause much disability and to necessitate several hospital admissions. In March 1937, roentgenographic examination showed marked deformity of the left femoral head with mushrooming as well as widening of the femoral neck (Fig. 5). The hip-joint space was narrowed, and there were definite osteo-arthritic manifestations. Slight mottling of the neck and upper femoral shaft was present, as well as typical clubbing of the lower end of the femur. A flexion-adduction contracture gradually developed, with limitation of motion in all directions. The clinical picture resembled ordinary osteo-arthritis. At various times, physiotherapy, radiotherapy, and bed rest with weight traction were administered. Only the latter seemed to produce any benefit, and even then the pain tended to recur with undue activity. In 1937 also, the diagnosis was finally confirmed by puncture of the sternal bone marrow, which revealed the typical Gaucher cells.

Surgical arthrodesis of the hip was seriously considered, but the Hematology Department advised against this in view of the presence of thrombocytopenia and leuko-

penia, and the possibility of hemorrhagic complications. After this admission in 1937, a Thomas caliper tuber seat brace was applied and gave relief for a considerable period. In January 1941, the patient's activity was much restricted by pain, but she no longer required the brace. Further roentgenographic examinations showed little or no change in the condition of the hip.

CASE 6. L. R. (Courtesy of the late Seth Selig, M.D.), male, was first seen in 1939, at the age of twenty-nine. He is the brother of the patient in Case 4. He had had intermittent pain and swelling about the left knee for some years, with a rather persistent limp. In the year before, increased pain and limp in the left hip were present. At the first examination, there was tenderness over the lateral aspect of the left hip. A flexion contracture of the hip at 135 degrees was present, with limited abduction, adduction, and rotation.

Roentgenograms showed a distortion of the left femoral head, which was elongated and flattened. The medial half was cystic, but the joint space and acetabulum were relatively normal. The diagnoses of old tuberculosis, old Legg-Perthes disease, or old slipped femoral epiphysis were suggested.

With no treatment but bed rest, the symptoms gradually subsided, leaving only slight limitation of extension, abduction, and rotation of the hip. Fusion of the hip had been considered elsewhere, but had been refused by the patient.

In October 1941, the patient returned for further examination. By this time, the authors were aware of the findings in his sister, Case 4, and recognized Gaucher's disease as the underlying cause of the hip lesion. The man was somewhat pallid, and his skin and mucous membranes were subicteric. The spleen was enlarged to four fingers below the costal margin. Further roentgenographic study of the lower femora showed the typical

FIG. 5

Case 5. F. K. May 25, 1939. Collapse of left femoral head with marked osteoarthritic symptoms.

FIG. 6

Case 6. L. R. October 11, 1941. Deformity of femoral head and coxa vara in adult hip. Marked osteo-arthritic symptoms.

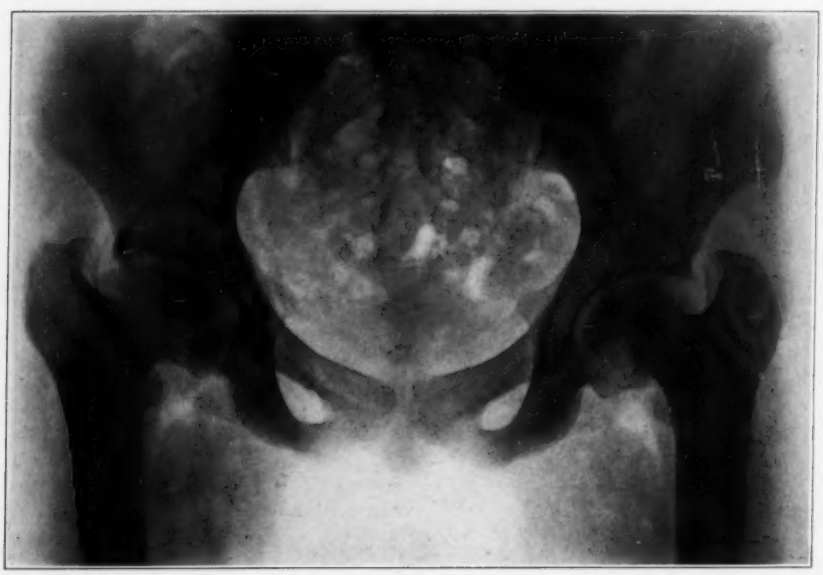

FIG. 7

Case 7. F. R. December 2, 1937. Bilateral distortion of femoral heads with coxa vara in young adult. No symptoms as yet.

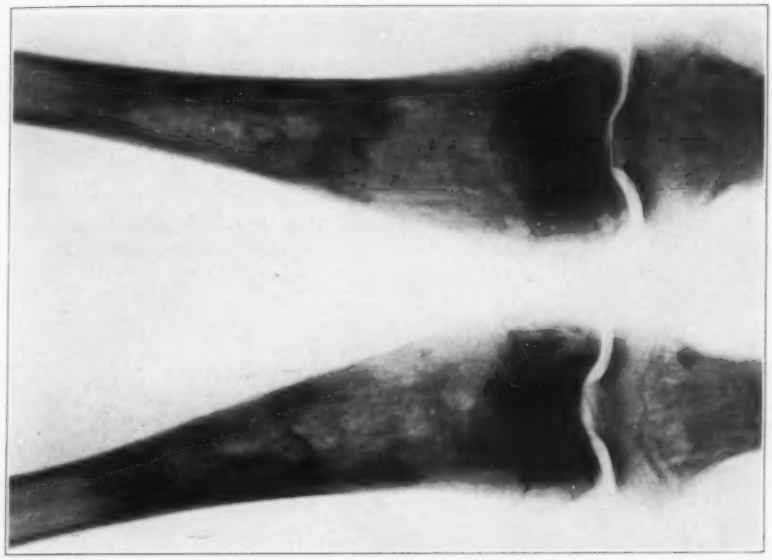

FIG. 8-B

Case 8. Characteristic lower femoral changes (postmortem specimen).

FIG. 8-A

Case 8. Bilateral deformities of the femoral head with coxa vara.

FIG. 8-C

Case 8. Collapse of the vertebrae with kyphosis.

changes of Gaucher's disease, with clubbing, thinning of the cortex, and infiltration of the medulla. The hip joint presented the same appearance as before (Fig. 6).

This is the only case not verified pathologically.

CASE 7. F. R. (Hospital No. 417222). A Jewish girl was first admitted to the Mount Sinai Hospital in 1923, when she was three and one-half years old. The presenting complaints were prominence of the abdomen, and epistaxis. An enlarged spleen and liver, and purpura were found. All roentgenographic findings were normal. A splenectomy was done, and the pathological diagnosis was Gaucher's disease.

Her next admission was in March 1934, when she complained of pain and swelling of the left knee of seven years' duration. There was also occasional pain in the left hip. The left knee was enlarged by periarticular thickening, and widening of the upper end of the tibia and fibula. There was outward bowing of the leg at its upper end. Roentgenograms showed a transverse, pathological fracture of the left tibia two inches distal to the knee joint. In the hips, there was marked mushrooming of the femoral heads with coxa vara deformity on both sides. Areas of transparency and mottling were present in the lower ends of both femora. The leg deformity was corrected somewhat under anaesthesia, and the fracture was treated in a plaster cast. After prolonged plaster fixation, it gradually united with persistent bowing, union being firm only in May 1935.

Roentgenographic examination in December 1937 revealed the changes described previously. There was clubbing of the lower ends of the femora, and still marked flattening of the femoral heads with coxa vara deformity (Fig. 7). No symptoms or signs of hip involvement were noted at this time nor have any developed since. At her last examination in 1941, this patient was asymptomatic, working, walked without limp, and had full range of motion in both hips. Slight persistent bowing of the left leg was still noticeable. In this girl, the hip involvement is so far of minor clinical importance. She is still young and future disability may develop.

CASE 8. S. F. (Reported in detail by Melamed and Chester). In this Jewish male, symptoms of "arthritis", involving many joints, first developed in 1921, at the age of twelve. Splenomegalia, failure to gain weight properly, and anaemia gradually appeared. In 1922, diagnosis of Gaucher's disease was made by splenic puncture. Four years later, nasal and oral hemorrhages took place, and splenectomy was performed. In 1928, there was a recurrence of joint pains. By 1930, spinal pain and deformity (gibbus) were marked, and there was a considerable decrease in the height of the trunk. Marked hepatic enlargement had occurred together with abdominal pressure symptoms. Collapse of several thoracic vertebrae were demonstrated in 1931.

On his final admission, he was poorly developed, anaemic, and had typical pinguecululae. The lymph nodes in the neck, axilla, and groin were enlarged. A marked thoracic kyphosis with compensatory lumbar lordosis was present, as well as a huge liver. Generalized bone tenderness was present, but no definite symptoms or signs relating to specific joints were noted.

Blood studies showed a marked secondary anaemia. Biopsy of an axillary lymph node showed it to be full of Gaucher cells.

Roentgenographic study showed numerous collapsed vertebrae (Fig. 8-C). The pelvis showed cystic changes in the innominate bones, especially near the acetabulum and bodies of the pubis. The femoral heads were flattened and irregularly mushroomed. Cystic changes were present throughout the heads and shafts with broadening of the latter (Fig. 8-A). The lower ends of the femoral shafts showed the typical clubbing or bottle shape (Fig. 8-B). Other less marked changes were present in the right fibula and tibia, as well as in the left radius and right humerus.

Postmortem examination showed the osseous type of Gaucher's disease. There was involvement of the lymph nodes, liver, spinal column, femora, pelvis, right humerus, left radius. Heterotopic bone-marrow formation was found in the liver.

In this patient, the hip changes were only incidental and gave rise to no symptoms or signs. It is likely that the extensive involvement of the bones resulted from the removal of the spleen in early life.

## SUMMARY AND CONCLUSIONS

From a study of eight cases of Gaucher's disease with hip-joint involvement, classified on the basis of age group and roentgenograms, it appears that treatment by prolonged rest is indicated to minimize deformity in the patient in the younger age group.

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# THE TOCOPHEROLS (VITAMIN E) IN THE TREATMENT OF PRIMARY FIBROSITIS

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William Balfour, an Edinburgh practitioner, first described the occurrence of fibrous thickenings in chronic muscular rheumatism in 1816. On this subject he wrote a book, in which he described numerous nodular tumors and fibrous thickenings which were painful on pressure and which caused referred pain. The term fibrositis was coined by Gowers almost 100 years later (1904). Stockman [23] described the pathology of fibrositis in the same year, although he failed to differentiate between the pathology of primary and secondary fibrositis in this description. Llewellyn and Jones wrote a book on fibrositis in 1915. Stockman [24] wrote several excellent chapters on fibrositis, panniculitis, and Dupuytren's contracture in his book "Rheumatism and Arthritis" which was published in 1920. In England, Telling stressed the clinical importance of fibrositis in general practice in 1935, and Slocumb brought its attention to the American physician in 1936.

Kelchner's definition of fibrositis, which was taken from Stockman [24], is all-embracing. He states, "Fibrositis is a rheumatoid disorder characterized by a non-suppurative inflammatory reaction in the white fibrous connective tissue, anywhere in the body, with a swelling and proliferation of the fibrous tissue in response to chilling, toxic influence, trauma, or fatigue. Acutely tender fibrous bands and nodules frequently form in the muscles, tendons, ligaments, fasciae, periosteum, joint capsules, and nerve sheaths, and press on arterioles and nerve filaments, causing muscle spasm and secondary pressure effects." Fibrositis is no more one disease than is anaemia or arthritis. The primary type is of unknown etiology. The secondary type is part of the picture of some general infection—such as rheumatic fever, influenza, gonorrhoea, syphilis, atrophic arthritis—or a systemic disease,—such as hypertrophic arthritis, gout, plumbism, or alcoholism. The primary type may be classified according to the type of tissue, muscle, or group of muscles involved. The most frequent muscles involved are the sternocleidomastoid, the trapezius, the intercostal, the latissimus dorsi, the serratus anterior, the serratus posterior inferior and superior, the splenius capitis and cervicis, the sacrospinalis and semispinalis capitis, semispinalis dorsi and cervicis, and the small deep muscles of the back; the deltoid, and the muscles of the scapula,—such as the teres major, the rhomboidei, the suprapsinatus and infraspinatus. Occasionally the muscles of the anterior abdomen (external and internal oblique, transversus abdominis, and rectus abdominis) are involved. The capsule and surrounding ligaments of various joints may be involved, at

which time the condition is spoken of as periarticular fibrositis. The bursae may be involved. The sheath of the sciatic nerve is often involved, and the condition is spoken of as perineural fibrositis. Tendons, fasciae, and aponeuroses may be involved. In the author's experience, the fascia lata, the inguinal ligament, and the palmar fascia of the hand have been frequently involved. Primary fibrositis may affect the subcutaneous fibro-areolar and adipose tissues.

Primary fibrositis is uncommon in young people. It usually manifests itself for the first time during the latter part of the fourth decade of life, and reaches its peak incidence in the fifth decade. Although most textbooks state that the disease occurs more frequently in males than in females, in the author's experience it has been equally divided between the sexes. The affected individual has the usual physical appearance of "good health". The disease may be acute or chronic. Acute attacks, not unlike that of gout, are the rule. However, these attacks usually last for a period of weeks, rather than days, which is characteristic of gout. Patients complain of severe pain and tenderness, which may be localized or generalized. The localized area may consist of a small tender nodule, the size of a pea, or may involve one muscle or group of muscles. These localized areas are not only tender, but are usually undurated and under spasm. The generalized condition is usually associated with generalized stiffness. Drafts and cold, damp weather definitely aggravate the condition or initiate an attack. Warm weather or the application of local heat brings relief. A slight degree of exercise usually limbers up these patients, and an excessive amount of exercise stiffens them again. Temporary deformities may occur during an acute attack. Thus an attack of fibrositis involving one of the sternocleidomastoid muscles may cause traction of the head to the affected side. Involvement of one group of the back muscles may cause a temporary lateral curvature of the spine. Fibrositis is usually characterized by the absence of an increased sedimentation rate, leukocytosis, or fever.

Stockman [24] has described the pathology of fibrositis at various stages: "Histologically they all consist of inflamed white fibrous tissue, the more recent ones being much less dense and containing more serofibrinous exudation than the older ones. The walls of the small blood vessels are much thickened, and the nerve filaments show interstitial inflammation". He showed one section of a small soft swelling, of about three weeks' duration, on the periosteum of the sternum. This section showed newly formed proliferating fibrous tissue, marked oedema, and many fibroblasts and blood vessels with many new capillaries. No leukocytic reaction was present. In another section, through a comparatively recent but older area of inflammation of the perimysium of the gluteus medius, new fibrous tissue was shown in a serofibrinous matrix. The fibroblasts were not numerous, and no leukocytes were present. All the coats of the small blood vessels showed very distinct thickening. Another section through an old, dense nodule from the heel showed closely packed fibrous tissue

with disappearance of the interspaces. Stockman also showed another section of chronic inflammation of the areolar tissue of the panniculus adiposus. Many fibroblasts were shown in the hypertrophied inflamed connective tissue. Interstitial neuritis was shown in the nerve twigs, and all walls of the blood vessels were thickened by increase in the connective tissue. Increased fat deposit was present in areas in which the

FIG. 1

Case 1. Photomicrograph (×400) showing polymorphonuclear infiltration, fibroblastic proliferation, and oedema.

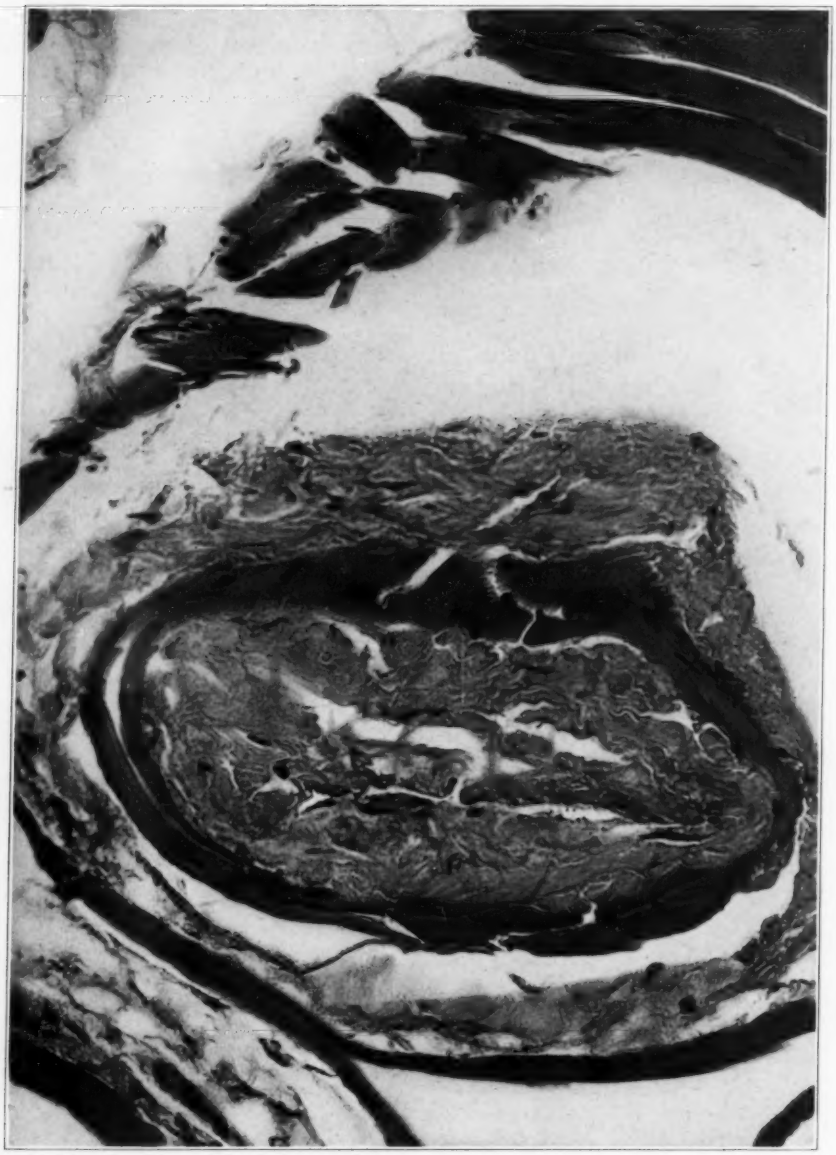

FIG. 2-A

Case 2. Photomicrograph (×400) showing a small area of hyaline degeneration of muscle with loss of cross striations and disappearance of nuclei.

inflammation occurred in patches. These patches were felt as small rounded fibrofatty tumors which were very painful on pressure, thus differentiating them from ordinary lipomata. He described the typical flexion deformities of the fingers occurring in Dupuytren's contracture as being due to the gradual contraction of this pathological fibrous tissue.

Abel and Siebert[1] described three stages in the pathology of primary

FIG. 2-B

Case 2. Photomicrograph (×400) showing large area of hyaline degeneration of muscle with loss of cross striations, disappearance of nuclei, and fibroblastic activity.

fibrositis,—acute, subacute, and chronic stages. The acute and subacute stages show hemorrhages, hyperaemia, serofibrinous exudate between the muscle bundles, newly formed fibroblasts, mild degenerative changes in muscle, swelling, loss of cross striation, and a few lymphocytes. The chronic stage shows fibrosis of muscle fascia and intramuscular septa, with separation of the muscle bundles, marked degeneration of the muscles

as evidenced by complete loss of cross striation, and hyalinization. There is also lobulation of perimuscular and subcutaneous fat.

CASE 1. A white female, aged fifty-seven, complained of attacks of generalized muscle stiffness and soreness of fourteen years' duration. These attacks lasted from one to thirty days. Her present attack consisted of soreness and stiffness of the back of the neck of several days' duration. A specimen for biopsy was taken from the trapezius

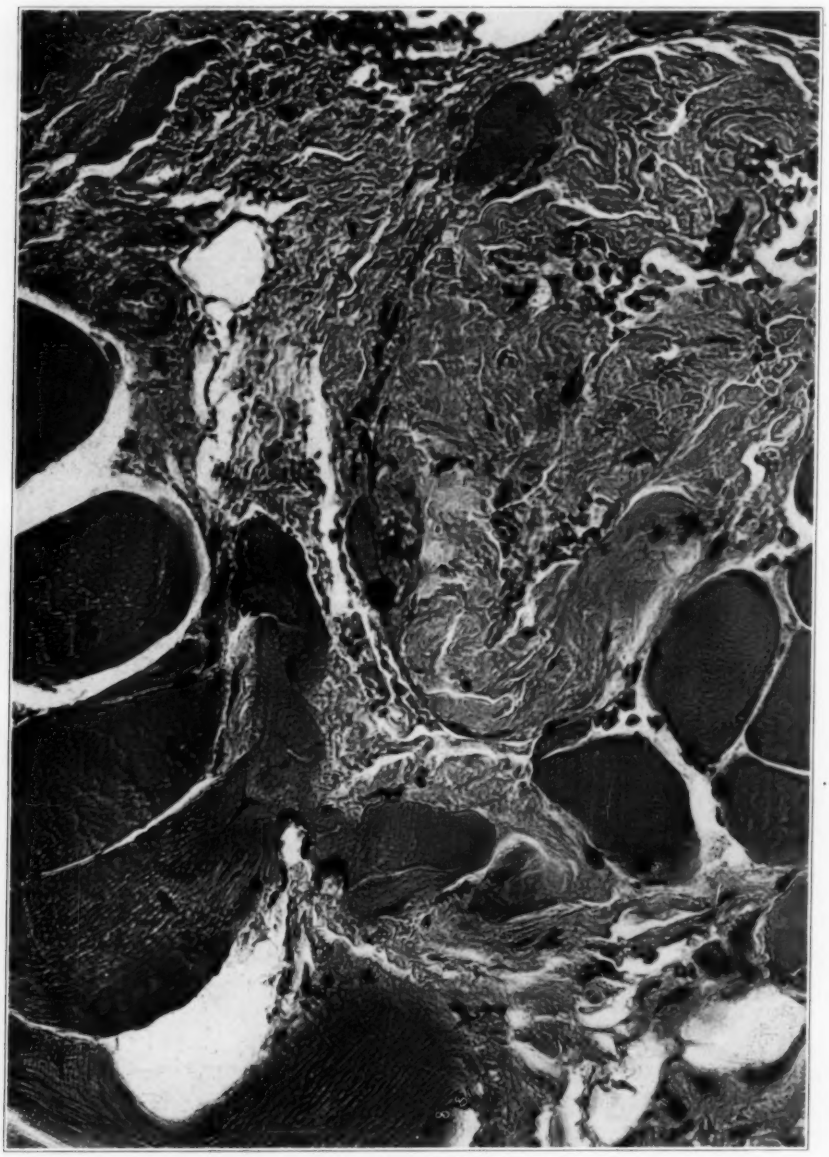

FIG. 3

Case 3. Photomicrograph (×400) showing hyalinization with loss of cross striations, disappearance of nuclei, and fibroblastic activity.

muscle. The acute stage of fibrositis is represented by Figure 1. Section from this tissue showed polymorphonuclear infiltration, fibroblastic proliferation, and oedema. This patient had been diagnosed as a psychoneurotic by several physicians. Compare this with normal muscle (Fig. 6).

CASE 2. A white female, aged twenty-two, complained of severe pain in the entire back, of thirty-two months' duration. The onset was acute, after the patient had sus-

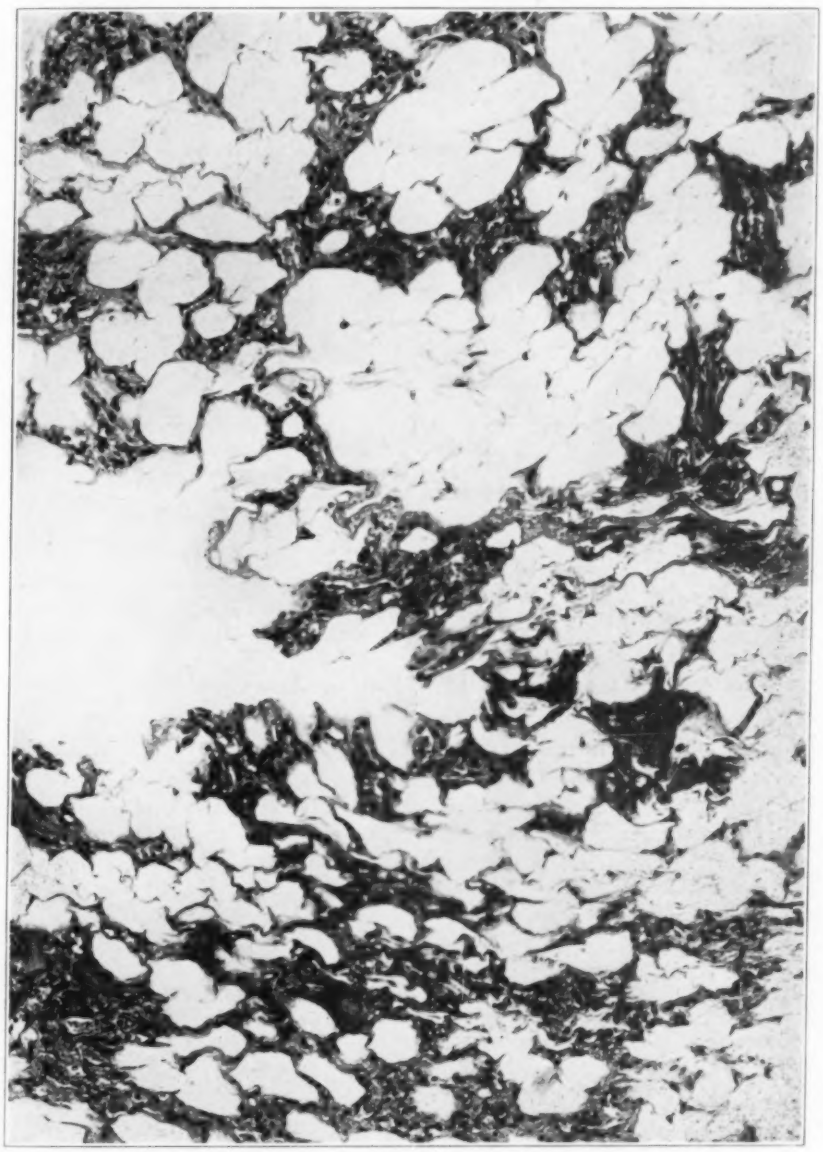

FIG. 4

Case 4. Photomicrograph (×400) of a nodule showing fibroblastic activity with increased local fat deposit.

FIG. 5

Case 5. Roentgenogram of the pelvis showing calcification of the sacrotuberous ligament.

tained a blow on the back. Marked tenderness was present over all the soft tissues of the back. Roentgenograms of the vertebrae and pelvis were negative. Sedimentation rate was 0.30 millimeters per hour (Wintrobe and Landsberg method); uric acid, 1.9 milligrams per 100 cubic centimeters; and serum phosphatase, 1.22 Bodansky units. Biopsy sections from the trapezius muscle showed one small area (Fig. 2-A) and one large area (Fig. 2-B) of hyaline degeneration of muscle, with loss of cross striations and disappearance of nuclei.

CASE 3. A white female, aged fifty-four, complained of attacks of lumbago over the previous two years. These attacks lasted from two to seven weeks. The present attack was in its second week. Examination revealed marked tenderness, induration, and spasm of the muscles of the lower back. Sedimentation rate was 0.42 millimeters per hour (Wintrobe and Landsberg method); uric acid, 1.5 milligrams per 100 cubic centimeters; and serum phosphatase, 3.3 Bodansky units. Roentgenograms of the pelvis and spine were negative. Biopsy sections from the latissimus dorsi showed hyalinization with loss of cross striations, disappearance of nuclei, and definite fibroblastic activity (Fig. 3).

CASE 4. A white female, aged fifty-five, complained of tender nodules on the right forearm and right leg of three week's duration. These nodules were very painful and tender. Biopsy of one of these nodules (Fig. 4) showed marked fibroblastic activity with increased local fat deposit. This picture is not unlike that described by Stockman [24] as occurring in panniculitis.

CASE 5. A white male, aged fifty-four, complained of backache of five months' duration. He stated that his backache was caused by lifting a heavy weight. He had pain also in the soft-tissue structures of the palms of his hands of three weeks' duration. Pain was produced by either flexion or extension at the hips. Sedimentation rate was

0.48 millimeters per hour (Wintrobe and Landsberg method). Roentgenograms of the pelvis (Fig. 5) showed calcification of the sacrotuberous ligament. This represents one of the end stages of fibrositis when the ligaments are affected.

FIG. 6

Photomicrograph (×400) of normal muscle showing normal cross striations and arrangement of nuclei. Compare this with the pathological changes in the above cases.

The pathology of primary fibrositis and that of nutritional muscular dystrophy occurring in young rats, as described by Pappenheimer, are strikingly similar. The early stages of nutritional muscular dystrophy show marked interstitial oedema, in part fibrinous. Marked inflammatory reaction with polymorphonuclears is present. The oedema soon disappears and the polymorphonuclears are replaced by mononuclear histiocytes. This is followed by calcification of the necrotic fibers. Nutritional muscular dystrophy was first described by Goettsch and Pappenheimer in rabbits and guinea pigs in 1931. Evans [3] and his coworkers described degeneration of cross-striated musculature in rats whose diet was low in vitamin E. Knowlton and his coworkers described similar changes in skeletal muscle, resulting from diets deficient in vitamin E. Morgulis and Spencer in 1936, and Morgulis and his coworkers [17] in 1938, reported that at least two factors, both present in whole wheat germ were required to cure nutritional muscular dystrophy in rats: a water-soluble factor present in defatted wheat germ, and a fat-soluble factor present in the unsaponifiable matter of wheat-germ oil. Mackenzie and his coworkers [14] in 1940 were able to show that nutritional muscular dystrophy in the rabbit could be prevented and cured by alpha tocopherol in the absence of the water-soluble factor. They were able to refute the previous report of Morgulis and his coworkers [16, 17] that rabbits fed Pappenheimer's diet "13", deficient in vitamin E, required two factors for the structural integrity of their skeletal muscles. The water-soluble factor was not required. The antidystrophy requirement of the rabbit for prevention and cure of nutritional muscular dystrophy was found to be 0.6 to 1.0 milligrams per kilogram of body weight for alpha tocopherol. Another interesting observation of Mackenzie and McCollum was the establishment of simple criteria for the development and improvement of nutritional muscular dystrophy. It was found that a great increase in urinary creatine invariably attended the deficiency, and preceded gross symptoms by at least two weeks. A marked reduction in urinary creatine occurred within twenty-four to forty-eight hours after starting the administration of vitamin E.

Two previous communications [21, 22] have called attention to the value of vitamin E in the treatment of primary fibrositis. Sydenstricker has called attention to the fact that the fat-soluble vitamins A, B, E, and K seem to be requisite for the maintenance and repair of certain specialized tissues. It has been the writer's contention that vitamin E is necessary for the prevention of the particular type of abnormal connective-tissue changes which occur in primary fibrositis and for the cure of this condition. John and Günther, Evans and his coworkers [3], and Smith [20] have shown that more than a single chemical substance can function as vitamin E. The list of substances include hydroquinone itself, various ethers of durohydroquinone, chromanes, coumaranes, coumarines, coumarones, and alpha, beta, and gamma tocopherols. Over forty of these compounds show vitamin-E activity. This is nothing new in the field of biological

chemistry, as similar conditions exist in the case of vitamin D, vitamin K, and the estrogenic hormones.

This report concerns itself with various chemical combinations, physical forms, and routes of administration of the tocopherols in the treatment of primary fibrositis. Wheat-germ oil which contains alpha, beta, and gamma tocopherols was first employed by the writer in the treatment of primary fibrositis. It had several drawbacks: It was unpalatable; and it caused gastric disturbances and skin rashes. The assay of total tocopherols varies with different batches of wheat-germ oil. The tocopherol content of a molecular distillate of vegetable oils contains a fixed quantity of the tocopherols. Twenty cases of primary fibrositis were treated with this preparation. These patients were given 120 to 240 milligrams of total tocopherols daily. Marked improvement was noted in all cases. Forty more cases of primary fibrositis have been treated with this molecular distillate. These patients received 300 milligrams of total tocopherols the first week and then 150 milligrams of total tocopherols daily. Most of these patients manifested improvement in a period of one week of such treatment, and all except five were completely relieved of their fibrositic symptoms. These five patients were relieved from pain, but not completely from generalized stiffness.

Hickman and his coworkers have found that 95 per cent. of the tocopherols administered by mouth are excreted in the faeces of healthy individuals. Therefore, it was decided to try the parenteral route. Nine patients with primary fibrositis were given 334 milligrams of mixed tocopherols (alpha, beta, and gamma tocopherols) intramuscularly at weekly intervals. All had severe local reactions, consisting of swelling, pain, and increased local heat at the site of injection. Two had systemic reactions, consisting of fever, nausea, and vomiting. All these patients were observed for a period of three weeks, at which time this mode of administration of the molecular distillate had to be stopped. All noted marked relief in their fibrositic symptoms, and one patient showed complete disappearance of the fibrositic nodules (Fig. 4).

Each of twelve patients with primary fibrositis was given 200 milligrams of synthetic alpha tocopherol in corn oil intramuscularly at weekly intervals. These patients were observed over a period of two to four months. All noted marked relief in their fibrositic symptoms.

The inunction route was tried in four cases; 0.30 cubic centimeters of 40 per cent. solution of the molecular distillate containing alpha, beta, and gamma tocopherols was rubbed into the skin daily. These patients were observed over a period of two months. They objected to the bad odor of the drug; the results were poor.

Two salts of the tocopherols were tried in twenty-two cases of various muscle disorders. Twelve patients received 0.065 of a gram of alpha tocopherol succinate capsules by mouth three times daily. These patients were observed for a period of two to four months. Nine cases of primary fibrositis were completely relieved. No relief was obtained in one

case of secondary fibrositis and two cases of psychosomatic rheumatism. Ten cases of fibrositis received 0.065 of a gram of gamma tocopherol palmitate three times daily by mouth. These cases were observed over a period of two to four months. Complete relief was obtained in six cases of primary fibrositis. One patient with secondary fibrositis noted mild relief, but this patient noted marked relief with the oral molecular distillate. One patient with secondary fibrositis noted moderate relief. No relief was obtained in one patient with combined sclerosis complicating pernicious anaemia, and in one case of osteitis deformans. Sixty cases of primary fibrositis have been successfully treated by the oral administration of a molecular distillate of the tocopherols. Twenty-one cases of primary fibrositis were treated successfully by the intramuscular injection of alpha tocopherol or the molecular distillate. Alpha tocopherol succinate and gamma tocopherol palmitate were successfully used in the treatment of fifteen cases of primary fibrositis.

These clinical experiments indicate that either the oral or parenteral routes are equally efficacious. The striking similarity between the pathological changes of primary fibrositis and nutritional muscular dystrophy is no mere accident. This fact, plus the marked clinical improvement obtained in both conditions by giving the tocopherols, indicate that primary fibrositis is a metabolic disorder concerned with the deprivation of vitamin E. This paper concerns itself only with the antidystrophy biological factor of vitamin E. The recommended dosage at the present time is 300 milligrams of mixed tocopherols daily for the first week, and 150 milligrams by mouth daily for the next two weeks. A maintenance dose of 100 milligrams daily may be continued indefinitely. The calculated maintenance requirement of 1 milligram of the tocopherols per kilo of body weight should suffice for the average individual.

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# SURGICAL TREATMENT OF PAINFUL HIPS OF ADULTS*

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The relief of painful hips of adults seems to the authors to be one of the main problems before orthopaedic surgeons. Certainly, for those who examine many adult patients it is a common cause of symptoms, severe enough to cause many persons to seek relief. In many instances, it becomes a severely disabling condition. The authors have attempted to give relief to these patients by surgical measures.

A comparison of this report with the review of a group of cases reported by Henderson and Pollock, reveals an increase in the use of surgery in an effort to give these patients some relief. Henderson and Pollock reviewed the results of various surgical procedures carried out over a period of twelve years from January 1, 1926, to December 31, 1937, inclusive. In that period seventy-seven surgical operations were performed. It should be noted that their cases were of hypertrophic arthritis only, while the authors' included some cases of other types, although the underlying factor producing pain in all was probably hypertrophic change.

From 1938 to 1940, inclusive, seventy-one patients were treated by various surgical procedures. Seventy-six operations were carried out; four patients had operations on both hips, and one had two operations on the same hip.

The notable changes in the use of each procedure in this group, when compared with the work of Henderson and Pollock, are:

1. The abandonment of manipulation;
2. The decrease in the number of "drilling" operations;
3. The practical abandonment of cheilotomy;
4. The decrease in the number of reconstruction operations;
5. The increase in the use of acetabuloplasty;
6. The increase in the number of arthrodeses;
7. The increase in the use of arthroplasty.

These facts in themselves probably carry more weight than any long discussion of the merits or demerits of the various surgical procedures. The trends are obvious. The marked changes in the type of treatment selected reveal that these procedures in themselves are not yet stabilized, and that further modifications will be introduced in the methods of treatment for this condition.

* Read before the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 15, 1942.

TABLE I

CONDITION CAUSING PAINFUL HIPS IN SEVENTY-ONE CASES

| Condition | No. of Cases |
|---|---|
| Old septic arthritis | 9 |
| Shallow acetabulum | 7 |
| Slipped epiphysis (ancient) | 6 |
| Legg-Perthes disease (ancient) | 6 |
| Congenital dislocation | 5 |
| Fractured femoral neck (ancient) | 3 |
| Traumatic dislocation (ancient) | 3 |
| Fractured acetabulum (ancient) | 2 |
| Spondylitis with secondary hypertrophic arthritis of the hip | 2 |
| Otto pelvis | 1 |
| Septic arthritis with pathological dislocation | 1 |
| Chondrodystrophy with coxa vara | 1 |
| Multiple loose bodies | 1 |
| Cause indefinite, with or without history of trauma | 24 |
| Total | 71 |

The authors do not mean to convey the idea that treatment in all such cases is surgical. It is their opinion that surgical treatment holds more promise of improvement or relief in properly selected cases than does conservative treatment. This opinion is based on the fact that from 1938 to 1940, inclusive, an additional 116 cases were encountered in which operation was not performed. Operative procedures were recommended in twenty-six of these cases, but were refused by the patients. For the most part, conservative treatment was recommended in the remainder. This treatment consisted in measures to reduce stress and strain on the hip,—such as crutches, reduction in weight, limitation of activity, local application of heat, and massage. In some cases, roentgenotherapy was used. From these measures, improvement in the amount of pain was obtained in less than one-third of the cases which were followed. Only about one-sixth of the patients had any improvement in the range of motion.

The construction of the hip joint is such that almost anatomical perfection is necessary in order to maintain the normal relationship between the surfaces of the acetabulum and the head of the femur. Any sort of irregularity in either of these surfaces will, in time, lead to degenerative changes which, in most cases, will result in the production of painful symptoms as well as limitation of motion. Whether the painful hip of an adult is called malum coxae senilis or hypertrophic arthritis or something else, it is the authors' opinion that some change in the nice relationship between the surfaces of the femur and the acetabulum leads to a painful hip of the type considered in this presentation, though it is often difficult to discover the remote inciting factor. In this series of seventy-one cases, impressions were that the defects given in Table I predisposed to the condition found at the time of treatment.

RESULTS OF OPERATION

As would be expected, the best results, from the standpoint of relief of pain, were obtained in the group of twenty-two cases in which arthrodeses were performed. This operation, successfully accomplished, is by far the most certain means of relieving pain. It cannot be used in all cases, however, because: (1) by no means all patients are willing to undergo arthrodesis with the resulting loss of motion of the hip; (2) patients who have involvement of both hips cannot, as a rule, be subjected to this procedure; and (3) patients who have arthritis of the lumbar portion of the spinal column cannot be subjected to the procedure.

Aged patients do not tolerate the long fixation necessary to produce satisfactory arthrodesis, and, of course, fixation is not so easily obtained. In this series, the three failures were in the cases of the three oldest patients, aged sixty-eight, fifty-nine, and fifty-six years, respectively. The average age of the patients in whom arthrodesis was carried out was forty-one years. For younger patients, who have disability in a single hip, and who are willing to adapt themselves to the inconveniences attendant upon a stiff hip, arthrodesis is most certain to offer relief from pain.

In 60 per cent. of the patients in whom acetabuloplasty was carried out, improvement was noted in the relief of pain and the amount of motion. Acetabuloplasty [6] has less to offer than arthrodesis from the standpoint of the relief of pain. Although acetabuloplasty preserves motion, and although Smith-Petersen has stated that it has not given the results hoped for, the authors feel that it still has a place in the treatment of certain types of ailments of the hip, particularly among aged patients who cannot tolerate the more drastic procedure of arthroplasty [7], or the long confinement in plaster casts attendant upon arthrodesis.

Arthroplasty, using vitallium cups, was performed in thirteen cases. This procedure was introduced in 1939 by Smith-Petersen. It has been used widely since that time by orthopaedic surgeons. The rationale of the procedure and the technique of the operation need not be repeated here. That many orthopaedic surgeons have hoped that it would offer a satisfactory method of treatment in many cases of painful hips in adults is obvious. Although the group of cases included here is small, it would seem from the figures presented that arthroplasty has a definite use in the treatment in these cases. In nine (69 per cent.) of a group of thirteen cases, less pain was present after the operation than before; and in eleven (85 per cent.) the range of motion was improved. Although these results seem to indicate that the procedure is worth while, it should be noted that in some cases the relief of pain has not been marked. The authors have been disappointed in that particular respect in several instances. Perhaps too much has been expected. It is true that the patients often were better satisfied than were the authors. Perhaps with the lapse of time, the results will prove to be even better than had been hoped for. With improvement in the operative technique, better results than are indicated here may be obtained. Whether the reaction to the interposition of a

foreign substance will lead to changes sufficiently severe to cause further exacerbation of symptoms, time alone will tell.

For the present, it is the authors' belief that cup arthroplasty should be carried out in cases of bilateral conditions of the hip, or in cases in which the lumbar portion of the spinal column is involved with some type of painful condition which contra-indicates the use of arthrodesis. They also believe that, in cases in which the patients will not agree to arthrodesis, cup arthroplasty offers enough promise of improvement to justify its use.

Use of the drilling operation, as suggested by Mackenzie, or "*forage*", as described by Graber-Duvernay has received considerable recognition, particularly in the European literature. The authors' experience with the procedure has been less encouraging than at first seemed likely. Improvement was noted in less than one-half of the cases after this operation. It undoubtedly is true that in some cases a marked degree of relief has followed the use of this operation; the authors are tempted to use the procedure in cases in which a minimal amount of surgical trauma is indicated. The operation certainly carries little risk. It might find a wider application if used in cases of hypertrophic arthritis of hips in the early stages, before extensive changes in the size and shape of the component parts of the hip have taken place. It is often difficult to convince patients who have lesions in that stage that an operation should be performed.

The shelf reconstruction operations are used in cases of congenital dislocation or subluxation of the hip, in which hypertrophic or traumatic arthritis is a superimposed condition. Other procedures have been used so seldom that little comment is necessary, except to note again the marked decrease in the number of times cheilotomy was performed, and the decrease in the number of reconstruction operations, indicating the unsatisfactory experience which has been had with the latter type of procedure. Osteotomy has not been used widely; although a certain amount of improvement may be obtained, it seems that this improvement must be temporary.

## SUMMARY

The operation most certain to relieve pain in cases of painful hips is arthrodesis. Less certain relief of pain, but preservation of motion, will follow the use of cup arthroplasty. Acetabuloplasty offers a less certain means of treatment, but it has a definite place in certain types of cases, particularly among elderly patients. Drilling operations are indicated only in the earliest stages of hypertrophic arthritis of the hip joint.

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# SEVERE OSTEOPOROSIS (OR OSTEOMALACIA) ASSOCIATED WITH LONG-CONTINUED LOW-GRADE STEATORRHOEA

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## INTRODUCTION

Deficient absorption of calcium and phosphorus in infancy leads to rickets. Even in adults, when the bone growth has stopped, bone is not in a static condition. When calcium absorption is restricted in adults, a general rarefaction of the skeleton results, which is called osteomalacia.

In general, the cases in which this condition is evident fall into three main groups based on their etiology:

1. Pregnancy and insufficient calcium intake;
2. Starvation osteomalacia of war-torn people;
3. Idiopathic steatorrhoea followed by osteomalacia.

Recently the authors have had occasion to observe far-advanced osteoporosis in a female, aged thirty-four. The clinical, laboratory, and roentgenographic findings were typical of osteomalacia, yet, according to the history, the diet had always been good. This patient was rather carefully studied and followed to clinical improvement, and it is shown to be one belonging in the third group.

The patient was first seen in the Orthopaedic Department in August, 1937, because of pain low in the back and deformity of the spine, which was rigid, with dorsolumbar kyphosis. Any attempted motion of the back caused pain. She was undernourished and asthenic. Relevant points in the history were as follows:

From the age of nineteen she had suffered from intermittent diarrhoea for about six years. She was seen in the Medical Department of this Hospital in 1925 for the complaint of unexplained diarrhoea and anaemia. At that time fat utilization was decreased to 72 per cent. of intake. In 1934 she developed aching pain in the metatarsophalangeal joints, both knees, and both shoulders. These symptoms were exaggerated during cold weather. She recalled no febrile reaction or swelling of the joints. During the latter part of 1936 she noticed a progressively increasing kyphosis, and the pain in the back increased also, particularly in the lumbar region. The pain in the extremities had somewhat decreased. At this time she was fitted with a body brace. The impression was ankylosing spondylitis.

She was seen again in June, 1939, at which time she was still wearing the brace, and complained of only occasional pain in the back. In June, 1940, the patient returned to the Hospital, complaining of shortness of breath, progressive kyphosis, pain in the left ulna, marked weakness, and loss of weight. She weighed eighty-six pounds, and was able to be up only a few hours a day because of extreme weakness. Menses had ceased in June, 1938. Her appetite was somewhat subnormal, but she had no diarrhoea or other gastro-intestinal complaints. The patient stated she had taken at least a quart of milk daily for the past two years. She had not taken vitamin D; otherwise her diet was apparently adequate. She was financially able to obtain a good diet.

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Examination in June, 1940, revealed a cachectic female, thirty-four years of age, with marked kyphosis and resulting deformity of the sternum (Fig. 1-A). There were tender regions on both ulnae. The spine was rigid, and any attempt at motion caused pain.

Roentgenograms showed marked osteoporosis of the spine with compression of the vertebrae (Fig. 2-A). Both ulnae showed pseudofractures (Fig. 3-A) similar to those described by Looser in 1920. Roentgenograms also showed the typical deformity of the pelvis due to osteomalacia, and marked deformity of the sternum with osteoporosis (Fig. 4-A).

Gynecological examinations were reported as showing an infantile uterus.

The patient was admitted for study. The findings are reported in Table I. The blood picture was typical of severe osteomalacia. The patient was given a diet containing 1200 cubic centimeters (one and one-quarter quarts) of milk daily, and having a fat content of approximately seventy grams. No vitamin-D therapy was given, as it was wished to simulate the patient's previous diet. Under this regimen the patient was unable to retain calcium, but did retain phosphorus and nitrogen. The urinary excretion of calcium was very low—about one-tenth of the customary amount—and the faecal calcium equalled the intake. (These values indicate faulty absorption of calcium.) Examination of a faecal sample showed the fat content to be about 20 per cent. of the wet weight,—double the normal value. Gastric analysis showed a normal level of both free and combined acids.

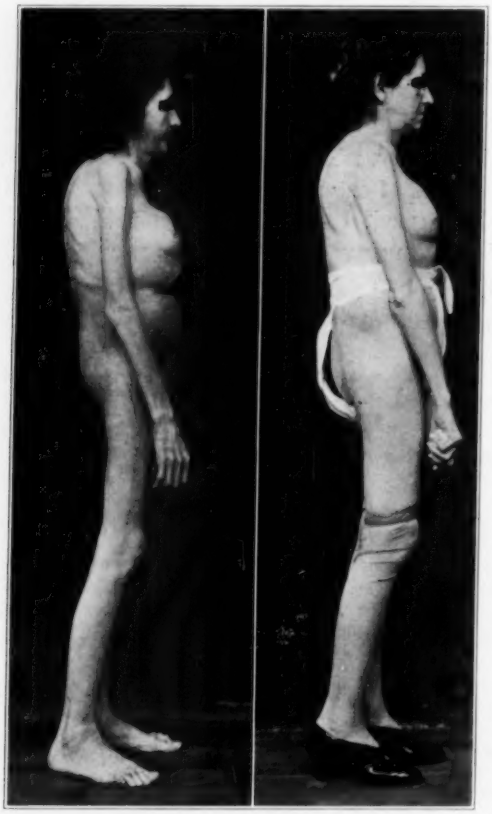

FIG. 1-A FIG. 1-B

Fig. 1-A: June 13, 1940. Patient at the beginning of treatment weighed eighty-six pounds.

Fig. 1-B: October 25, 1940. After four months of treatment patient weighed 100 pounds.

The patient's condition could be considered as due to vitamin-D deficiency, or to a chronic deficiency in absorption of fat, which is known to be associated with a lowered absorption of calcium from the intestine, or, more probably, to a combination of both factors. From the history, a continuous low-grade deficiency of absorption of fat seemed probable, and could account for the defective absorption of calcium. With increasing invalidism the patient would be indoors more and receive less ultra-violet irradiation; this, in turn, would decrease the absorption of calcium still further. A vicious cycle seemed inevitable under these conditions.

A study of the patient's dark adaptation showed her vitamin-A status to be normal. The decrease in fat absorption, then, was not sufficient to lead to a deficiency of vitamin A, which is carried in the dietary fat. Presumably, then, if the vitamin-D intake were ample, a sufficient amount of this vitamin could be absorbed.

Because of the severity of the patient's condition, and the fact

FIG. 2-B

October 25, 1940. Anteroposterior view of the spine shows calcium deposition in the thoracolumbar vertebrae after treatment.

FIG. 2-A

June 13, 1940. Anteroposterior view of the spine shows marked osteoporosis of the thoracolumbar vertebrae.

that she could not remain under close supervision, it was decided to make the therapy ample, both in the matter of vitamin-D intake and in aiding fat absorption. The patient preferred to drink whole milk, rather than skimmed milk. She was, therefore, sent home under the following regimen: one and one-half quarts of milk daily; two teaspoonfuls of cod-liver oil (1200 U.S.P. units of vitamin D) daily: bile salts, five grains, three times daily; pancreatin, five grains, three times daily; and calcium lactate, ten grains, three times daily. The prescribed diet was low in fat content, but nutritionally was ample. The patient was ordered to lie on a boarded bed. No endocrine therapy was instituted.

The patient was seen in September, 1940, and stated that she was much improved and had gained thirteen pounds. The regimen was continued.

The patient returned to the Hospital on October 25, 1940, three and one-half months after the beginning of her regimen. She weighed 100 pounds, a gain of fourteen pounds. The ulnae were no longer tender to palpation. The respiratory symptoms had disappeared, and the patient wished to be allowed up. According to the patient and her mother, the regimen had been followed strictly. She had menstruated for the first time in about two years.

FIG. 3-A

June 13, 1940. Pseudofractures of the ulnae.

Roentgenograms showed the findings as seen in Figures 2-B, 3-B, and 4-B. She was admitted to the Hospital and kept on the same regimen as before. The metabolic studies were repeated (Table I).

The blood findings were those of healing osteomalacia. The phosphatase value, though less than half the original value, was still sufficiently above normal to indicate that healing was not yet complete, even though the roentgenographic examination showed marked deposition of mineral in all bones. The urinary excretion of calcium had not increased, but the faecal excretion had decreased markedly, permitting a calcium retention of half a gram daily. The phosphorus retention had decreased, so that the ratio of calcium to phosphorus retained could now be considered optimal for mineralization of bone. It was assumed that the primary need had been for calcium rather than for phosphorus.

The pancreatin, bile-salt, and calcium-lactate therapies were discontinued, and the patient's retention of minerals studied with vitamin-D therapy only. The success of this study was somewhat marred by the incidence of a slight upper respiratory infection, which may have

been responsible for the diarrhoea which occurred for two days soon after the change in regimen. Notwithstanding the slight illness preceding the period of study, the retention of both calcium and phosphorus was excellent. The excretion of fat was notably increased, however; analysis of a single faecal specimen showed 41 per cent. of the wet weight of the stool due to fat, in contrast to 12 per cent. found during the previous period, with the same dietary intake.

Because of the sharp decrease in fat utilization two weeks after bile-salt and pancreatin therapies were discontinued, the patient was advised to return to the regimen with which she did so well. A Telson type of cast was applied to attempt to straighten the dorsum rotundum which was still present.

In April, 1941, the patient returned to the Clinic, stating she felt fine and had remained on her regimen. Her weight was 110 pounds,—a total gain of twenty-four pounds in eleven months. The blood findings indicated healing osteomalacia. The patient has menstruated regularly since October, 1940. She was advised to remain on the dietary regimen, but to return to work.

The patient returned for a check-up in July, 1941. She had been working at sorting fruits in a cannery and had maintained her weight. Blood phosphatase was thirteen and six-tenths Jenner-Kay units.

In January, 1942, the patient was again examined and was found to be in good condition.

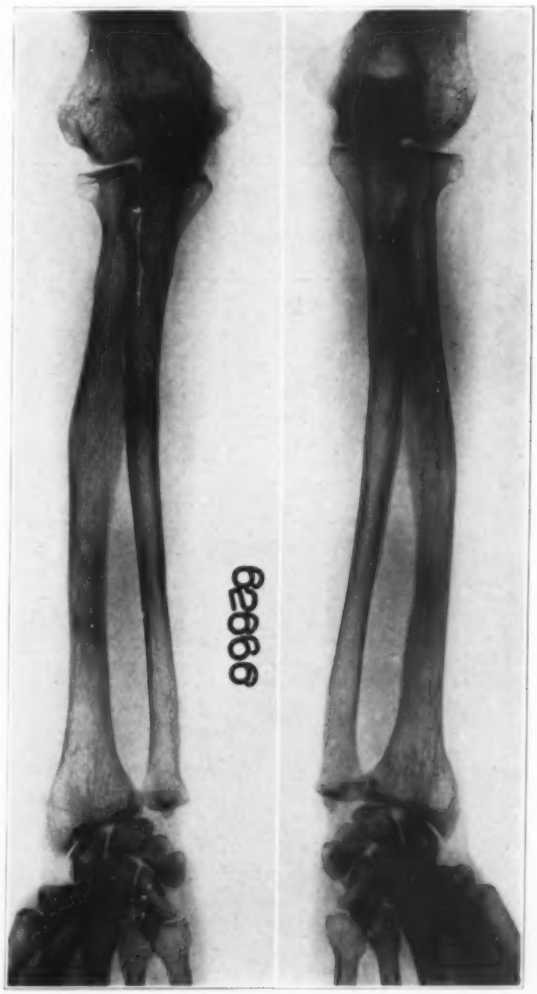


FIG. 3-B

October 25, 1940. Healed pseudofractures of the ulnae.

## DISCUSSION

A severe and rapidly progressing osteomalacia developed in this patient apparently within the course of four or five years. The history suggests that impairment of fat absorption, occasional or constant, preceded the onset of osteomalacia by about ten years. The impairment had not been sufficiently marked to cause diarrhoea for the previous eight or nine years; yet during this period the effects of the mineral deficiency became apparent and progressed rapidly. It is well known

TABLE I

METABOLIC STUDY OF A WOMAN, THIRTY-FOUR YEARS OLD, WITH SEVERE OSTEOMALACIA

| Date and Therapy | Essential Substances in Diet | Daily Intake (*Grams*) | Daily Excretion | | | Daily Retention (*Grams*) | Serum | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Urine (*Grams*) | Faeces (*Grams*) | Total (*Grams*) | | Calcium (*Milligrams per 100 Cubic Centimeters*) | Phosphorus (*Milligrams per 100 Cubic Centimeters*) | Phosphatase* *U/100* |
| July 1 to 6, 1940<br>No therapy | Calcium<br>Phosphorus<br>Nitrogen<br>Fat | 1.366<br>1.546<br>12.58 | 0.016<br>1.041<br>8.86 | 1.360<br>0.236<br>1.82<br>19.5%** | 1.376<br>1.277<br>10.68 | *− .010*<br>+ .269<br>1.90 | 8.8 | 2.5 | 36.3 |
| November 1 to 6, 1940<br>Vitamin D<br>Bile salts<br>Pancreatin<br>Calcium lactate | Calcium<br>Phosphorus<br>Nitrogen<br>Fat | 1.619<br>1.574<br>13.04 | 0.011<br>1.250<br>9.83 | 1.082<br>0.194<br>1.46<br>12.33%** | 1.093<br>1.444<br>11.29 | *+ .526*<br>+ 130<br>1.75 | 10.1 | 4.0 | 17.6 |
| November 16 to 21, 1940<br>Vitamin D | Calcium<br>Phosphorus<br>Nitrogen<br>Fat | 1.616<br>1.743<br>12.67 | 0.009<br>1.136<br>8.32 | 1.203<br>0.232<br>2.74<br>41.0%** | 1.212<br>1.368<br>11.06 | *+ .404*<br>+ .375<br>1.61 | | | |
| July 23, 1941 | | | | | | | | | 13.6 |

* Jenner-Kay units of phosphatase, — normal value 6 to 10 units.
** Percentage of wet weight of faeces.

FIG. 4-B

FIG. 4-A

Fig. 4-A. June 21, 1940. Lateral view of the spine shows far-advanced osteoporosis.
Fig. 4-B. October 27, 1940. Lateral roentgenogram of the spine, following eight months of treatment, shows the deposition of calcium to be most marked along the intervertebral spaces.

that chronic steatorrhoea (celiac disease, sprue, Gee's disease) is associated with impaired absorption of bone minerals, and leads to the development of rickets or osteomalacia.

A steatorrhoea so slight as to be symptomless most of the time is not usually associated with the development of so severe an osteomalacia. It is to be regretted that a more complete determination of the relative rôles played by vitamin-D deficiency and by the steatorrhoea could not have been made in this patient. With the aid of vitamin D, she was able to maintain, at least temporarily, the ability to absorb calcium and phosphorus, notwithstanding a high fat excretion. How long she could have continued to do so was not determined. The increased excretion of fat must necessarily remove from the gastro-intestinal tract a considerable quantity of the fat-soluble vitamins, necessitating a larger vitamin-D intake than would be needed by the normal adult. It seems that adequate vitamin-D therapy should be given to all patients with a history of chronic diarrhoea to prevent the development of osteomalacia.

This case of osteomalacia is of further interest because the accompanying amenorrhoea might have been considered evidence of endocrine imbalance. The temptation to use endocrine therapy is always great because of the occasional dramatic changes brought about with its use. With the history obtained from this patient, the presence of sufficient nutritional factors was obvious. Regulation of the patient's nutrition proved the endocrine imbalance to be dependent upon the faulty nutrition rather than the reverse.

FIG. 5

April 24, 1941. Malacic deformity of the pelvis.

SUMMARY

A far-advanced case of osteomalacia appears to have developed in the absence of marked dietary indiscretions. The milk intake had been ample for at least two years, but no additional vitamin D had been ingested.

The patient showed a persistent elevation of faecal fat. The history indicated that some degree of steatorrhoea had been present for more than ten years. It seems probable that this mild degree of steatorrhoea over so long a period was a major factor in the development of the osteomalacia. Retention of bone minerals was ample when cod-liver oil, bile-salt, and pancreatin therapies were instituted in conjunction with the ingestion of a diet rich in calcium and phosphorus, and low in fat content.

The authors have encountered one other patient whose spine shows far-advanced osteoporosis and whose stools show elevated faecal fat. It is too early to tell what results dietary and medical management will produce in this case. But it is possible that in a certain number of cases of so-called idiopathic osteoporosis, the primary fault lies in the patient's inability to digest fat.

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# SYNOVIOMA OF THE KNEE JOINT

## A Case Report

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Tumors of the articular synovial membrane, most commonly termed synoviomata, are now well recognized, although encountered comparatively infrequently. The prognosis is, as a rule, not favorable, because the tumor tends to recur locally and, in addition, may metastasize. Histological examination of the tumors which recur following operation demonstrates an increasingly malignant type of cell.

Because of the unfavorable prognosis in this relatively rare tumor, the following case is reported, in which the mass was excised, and there has not been a recurrence over a period of eight and a half years.

The patient, a grocery clerk, aged thirty-eight, was admitted to the Clinic May 9, 1933, because of pain and disability of the left knee, with particular reference to a swelling which had appeared on the side of the joint.

The patient stated that a swelling in the same region had been operated upon elsewhere fifteen years previously. His family was then informed that this was a bony growth. He had had no trouble with the knee following the operation until about eight years before he came under the author's observation, when a slight swelling appeared on the outer side of the left knee, and then disappeared after a month. There was no known cause, and the swelling recurred at intervals. This intermittent appearance of the swelling persisted until seven months previous to admission, when, while lifting a heavy box, his foot slipped, and almost immediately the swelling reappeared, this time much larger

FIG. 1

Preoperative photograph of left knee, showing cystic swelling on the lateral aspect of the knee region.

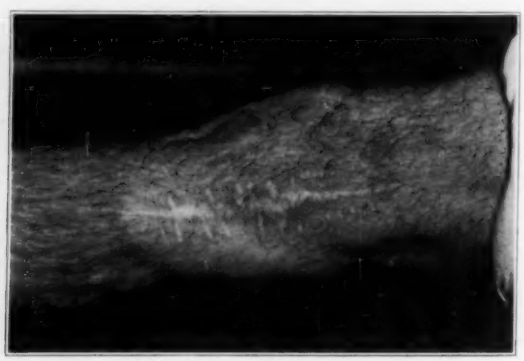

FIG. 2-A

Photographs taken eight and one-half years postoperatively, illustrate the normal range of motion in the knee joint. (See also Fig. 2-B.)

than it had ever been before. With this swollen joint he experienced severe pain in the knee, which persisted, together with a sense of numbness on the outer side of the lower leg, extending from the knee to the ankle region. While in previous attacks local application of heat had always caused the swelling to become less pronounced, after the injury described, heat had no effect upon the size of the swelling. There was no limitation of knee motion, and the joint was stable. The appearance of the knee on admission is shown in Figure 1.

FIG. 2-B

The findings on general medical examination were not remarkable. The local examination of the knee was negative except for the swelling, as illustrated. This was firmly attached to the underlying deep fascia, and apparently in part to the subcutaneous tissue, although the skin was movable over the tumor. The swelling was definitely tense and cystic to palpation, and moderately tender. Roentgenograms of both knee joints were negative. Routine urine and blood examinations, including a Wassermann test, were negative. Excision of the mass was advised, and the man was admitted to the New England Deaconess Hospital on June 12, 1933, and operated upon two days later. The preoperative diagnosis was cystic swelling of the lateral region of the left knee, type to be determined.

The mass was exposed by an elliptical incision, leaving intact the

FIG. 3

Photograph of specimen removed (actual size). The skin overlying the tumor was excised *in situ* while the tail-like projection, mentioned in the text, is coiled up and lying on the surface of the mass to the left.

skin directly over the tumor. The cystic mass was found to be firmly adherent to the underlying deep fascia, to the knee-joint capsule, and to the periosteum over the head of

FIG. 4-A

Low-power and high-power (Fig. 4-B) photomicrographs. The tumor tissue is somewhat lobulated and is infiltrating the adjacent connective tissue irregularly. The cells are spindle-shaped, without intercellular substance. In some places there is a tendency to the formation of whorls. There are frequent spaces, with some orientation of the tumor cells to line them. Mitotic figures are present, but rare. Diagnosis: synovioma of the knee, recurrence probable.

the fibula, as well as to the common peroneal nerve, and was separated from these structures with some difficulty. It was then found that the mass tapered off into a tail-like projection which entered the knee joint posterior to the lateral collateral ligament. The joint was opened, and the portion of the capsule immediately adjacent to this tail-like projection was excised. The projection was intimately adherent to the external semilunar cartilage, and seemed to arise from the synovial membrane in this area, which exhibited a local fold or thickening that extended around posteriorly to the midline. This

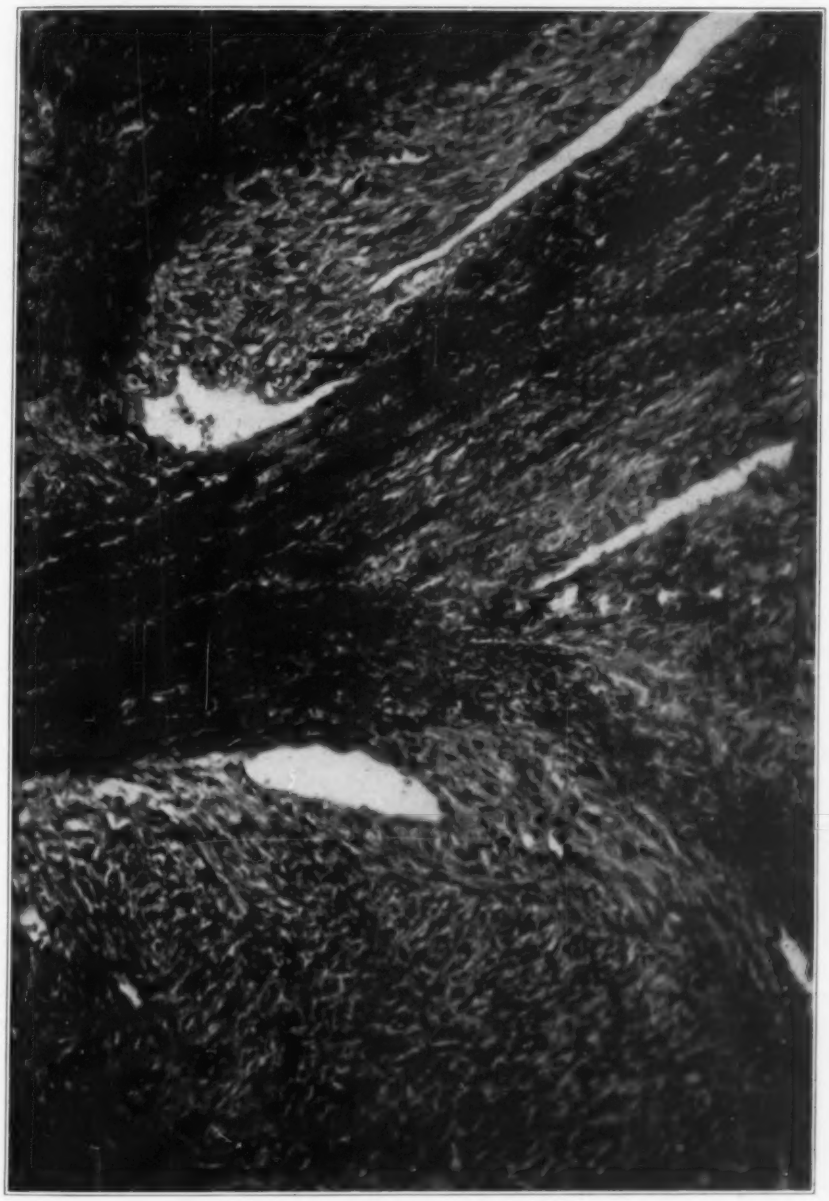

FIG. 4-B

synovial membrane was likewise removed, as was also the external semilunar cartilage.

In order to close the defect created by the excision of the skin overlying the mass, it was necessary to make an additional "releasing" incision, thus permitting primary suture of the operative wound. The secondary wound was covered with a Thiersch skin graft.

The immediate postoperative period was relatively stormy, as the patient reacted severely to the accumulation of serum in the knee, and, therefore, skeletal traction was applied to the os calcis. The joint was aspirated and local, hot, wet dressings were applied. Culture of the joint fluid was negative. Under this regimen, all reaction subsided, and the wounds healed without complication.

On the twelfth day after operation, the patient started on active exercises, and was discharged from the hospital ten days later, walking with crutches to protect the quadriceps muscle. He returned to his usual occupation six weeks after operation, and has continued in that work ever since. Figures 2-A and 2-B are photographs which illustrate the normal range of motion and absence of swelling at the present time. Figure 3 is a photograph of the excised mass, and Figures 4-A and 4-B are low-power and high-power photomicrographs of the tumor. Dr. Shields Warren made a diagnosis of synovioma, and stated that recurrence was probable.

Since operation the patient has been examined at least once a year and sometimes more often, as he occasionally has come to the Clinic because of other complaints that have had no relation to his knee, notably gastro-intestinal disturbances. His condition at the present time is excellent. He has no symptoms whatsoever in his knee, and the joint function is normal. He considers his general health very satisfactory. The last examination was made on October 4, 1941, eight years and five months following operation. There was no evidence of recurrence of the tumor. Roentgenograms of his knee and lungs were negative and examination of the extremity was negative.

## SUMMARY

The tumor mass originally appeared as a cystic swelling on the lateral aspect of the knee, and at operation was found to communicate with the knee joint and to arise from the synovial membrane in the posterior compartment of the knee. The tumor was firmly adherent to the external semilunar cartilage, which, together with the tumor mass, was removed. Eight years and five months after operation there was no evidence of recurrence, and the patient had normal function of the knee joint.

# TWO UNUSUAL TRAUMATIC DISLOCATIONS OF THE HIP

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The following cases are probably the most unusual that the authors have seen in a number of years.

CASE 1. J. L. R., a white man, forty-nine years old, was in an automobile accident on November 17, 1940, and sustained a posterior dislocation of the right hip (Fig. 1-A).

The roentgenogram at that time showed a dislocation of the right hip, with detachment of a large fragment of the superior lip of the acetabulum, measuring four by two centimeters. The head of the femur was displaced markedly upward.

Under gas and oxygen anaesthesia, the dislocation was reduced by the Allis method, and the patient was put up in Russell traction with ten pounds of weight. He was discharged from the Hospital on December 8, 1940, walking on crutches and not bearing any weight on the right leg.

On January 7, 1941, the roentgenogram showed the detached upper margin of the acetabulum to be in such a position as to form a projecting shelf over the head of the femur, 3 centimeters in length by one and one-half centimeters in diameter (Fig. 1-B).

On February 4, 1941, full weight-bearing was allowed.

The shelf, as formed by the fractured fragment, is the only one that the authors have ever seen. The hip is stable and painless, and allows an excellent range of motion.

The second case is one of the few traumatic, anterior dislocations of the hip seen here.

CASE 2. T. M., a colored man, twenty-four years old, was first seen in this Hospital on March 9, 1941, with the complaint that he had been struck on the left hip with an axe, approximately twenty hours before admission. He was found to have a large gaping wound over the left hip, through which protruded the head of the femur.

The roentgenogram showed the head of the left femur to be riding upward out of the acetabulum (Fig. 2-A). The head was displaced laterally and anteriorly, and the upper portion of the head was at a level two and a half centimeters above the superior border of the acetabulum. The greater trochanter was detached, forming a fragment five centimeters in its greatest diameter, and lying somewhat medial and above the head proper. There was a line running through the head extending three centimeters medial to the outer border, which was apparently due to an incised wound. There were several small bone chips lying in the soft parts.

The axe had apparently passed through the base of the greater trochanter and the superior margin of the neck into the head of the femur.

In the operating room a thorough débridement of the wound was carried out. Several loose bone fragments were removed from the wound, the dislocation was reduced, and the detached fragment of the greater trochanter was wired into place. Seven and one-half grams of sterile sulfanilamide powder was sprinkled throughout the wound. The capsule was closed, and several soft-rubber drains were inserted down to the capsule. The wound was then closed tight around the drains, and a hip spica was applied. The patient was given a prophylactic dose of tetanus and gas antitoxin, and was started on sulfanilamide (ninety grains per day) by mouth. He was also given prophylactic roentgen therapy to the left-hip region. The postoperative course was uneventful. On

FIG. 1-B

Case 1. Showing dislocation reduced, with fractured fragment now firmly united and forming a perfect shelf over the head of the femur.

FIG. 1-A

Case 1. Posterior traumatic dislocation of the hip, showing fragment from the superior rim of the acetabulum.

FIG. 2-B

Case 2. Dislocation reduced. A loss of bone from the superior edge of the neck and head of the femur is apparent.

FIG. 2-A

Case 2. Traumatic anterior dislocation of the hip, showing detached greater trochanter.

March 12, 1941, a window was cut in the cast, and the drains were removed. There was no evidence of infection, and the wound was healing satisfactorily. The cast was then reinforced, and the patient was discharged on March 30, 1941. On May 15, 1941, the cast was bivalved and motion was started at the hip.

On July 24, 1941, the roentgenograms showed the severed greater trochanter to be firmly united (Fig. 2-B). Full weight-bearing was started at that time.

On September 11, 1941, the patient was walking without a limp, the hip was painless, and there was a good range of motion (Fig. 2-C), except in flexion which was limited to about fifty degrees. The patient was allowed to return to work at that time.

FIG. 2-C

Case 2. Demonstrating range of abduction.

This second case is of special interest because the question of closure of the wound twenty hours after the injury had to be considered.

The wound was closed in spite of the fact that twenty hours had elapsed since the injury was received, because it was felt to be relatively clean. By using sulfanilamide powder locally and orally, and by using drains for forty-eight hours, it was believed that the chances for obtaining a good functioning hip joint would be better than if the wound were left open.

It was felt that in Case 2 the primary closure was certainly responsible for part of the good functional result to date. In general the authors do not advocate closure of wounds that are of over eight hours' duration, but the surgeon must utilize his personal judgment as against fixed principles.

In these cases it is of course too early to determine an end result in view of the possibility of development of aseptic necrosis of all or part of the head. [1] These patients will of course be followed, and the evaluation of the end results will not be determined before two years after the time of the injury.

1. BANKS, S. W.: Aseptic Necrosis of the Femoral Head Following Traumatic Dislocation of the Hip. A Report of Nine Cases. J. Bone and Joint Surg., XXIII, 753, Oct. 1941.

# ROENTGENOGRAPHIC STUDY OF ACUTE OSTEOMYELITIS OF THE FIBULA TREATED CONSERVATIVELY

BY RAPHAEL R. GOLDENBERG, M.D., F.A.C.S., PATERSON, NEW JERSEY

*From the Nathan and Miriam Barnert Memorial Hospital, Paterson* *

This case is presented because it gives a graphic demonstration of the destructive and reparative processes as depicted on the roentgenograms in a surgically undisturbed instance of acute osteomyelitis.

A. L., male, eleven years old, was admitted to the Nathan and Miriam Barnert Memorial Hospital on July 19, 1937, complaining of a feverish feeling and of pain in the left leg of five days' duration. On the day following the onset, he experienced a chill of five minutes' duration. The temperature rose to 104 degrees. The pain thereafter became so intense that the child was unable to move the left lower extremity. There was no history of preceding trauma or relevant illnesses.

FIG. 1

July 20, 1937. Small oval area of rarefaction immediately below the epiphyseal line.

On admission to the Hospital, the left lower extremity was held in abduction and external rotation with slight flexion at the hip and knee. There were local heat, redness, swelling over the anteromedial aspect of the proximal third of the left leg, and exquisite tenderness over the head of the fibula. On gentle manipulation the knee could be moved through a range of 80 degrees. The left calf was enlarged seven-eighths of an inch. The general examination was negative, except for several small abrasions over the legs and feet. The leukocyte count was 25,100, with 89 per cent. polymorphonuclears, many of which were young forms. The first blood culture revealed eight colonies of staphylococcus aureus, but the later cultures remained sterile. Urinalysis was negative save for a faint trace of albumen. Roentgenographic examination (Fig. 1) on July 20, 1937, the sixth day of the illness, was thought to be negative, but in retrospect a small oval area of rarefaction can be visualized immediately below the proximal epiphyseal line.

* Surgical Service of Dr. William Spickers.

FIG. 2

July 24, 1937. Area of rarefaction in the metaphysis with break in the anterior aspect of the cortex.

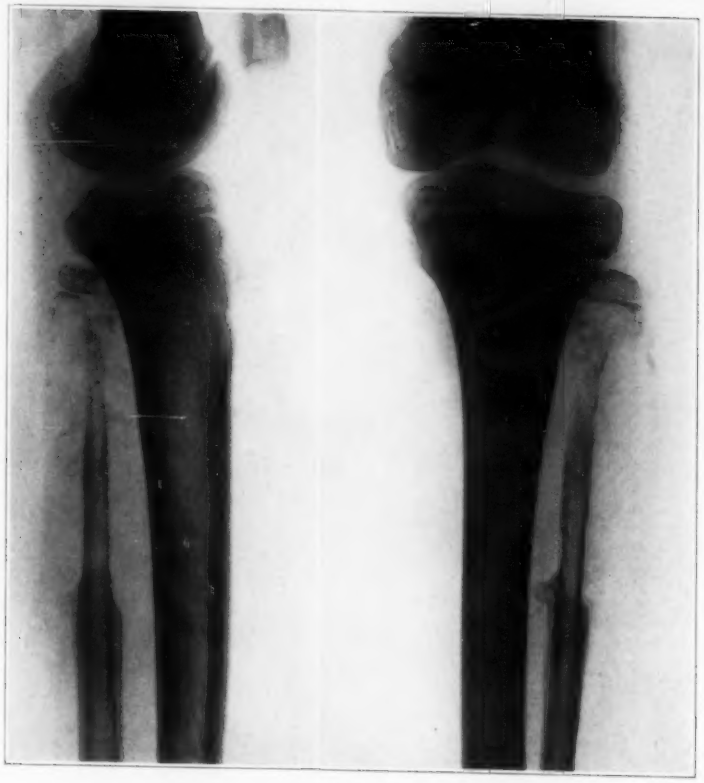

FIG. 3

August 13, 1937. Extensive destruction of the proximal four inches of the fibula.

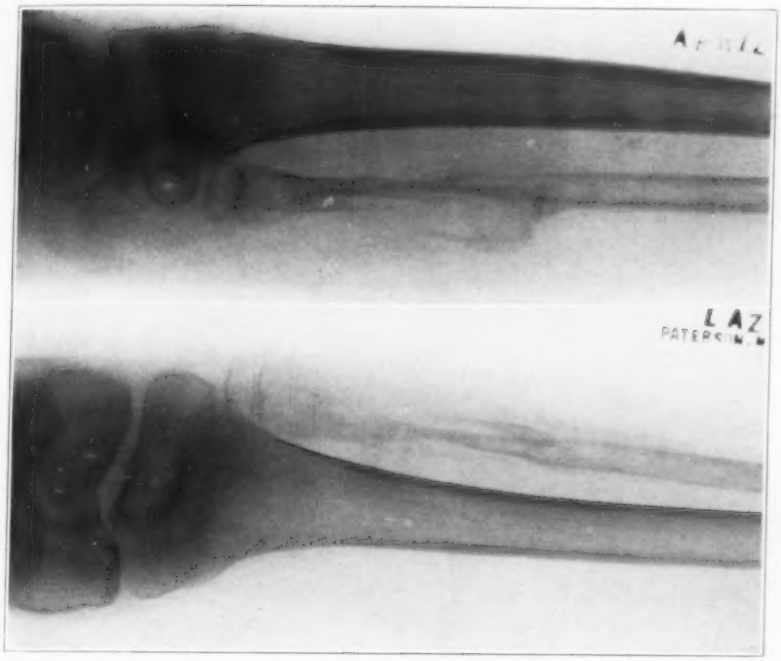


FIG. 5

April 1, 1938. Beginning reformation of fibula and medullary canal.

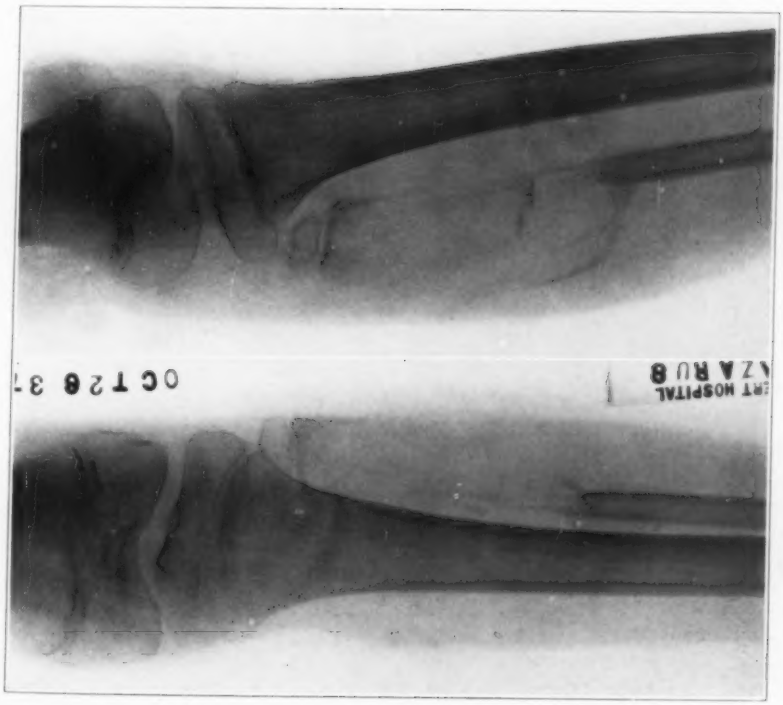


FIG. 4

October 26, 1937. Almost complete destruction of the proximal four inches of the fibula, with bulging of the partially ossified periosteum.

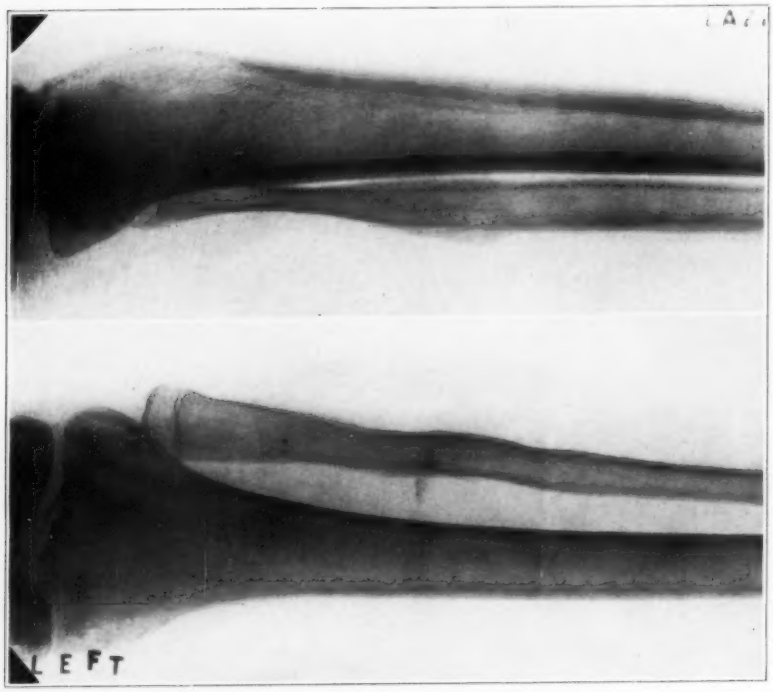


FIG. 7

September 14, 1940. Reformation of the fibula is almost complete. There are no areas of rarefaction suggestive of active disease.

FIG. 6

August 25, 1938. Further reformation of the fibula.

Because of a mistaken diagnosis of cellulitis, conservative therapy was instituted in the form of intravenous glucose in saline, and continuous wet magnesium-sulphate dressings. On the day after admission the temperature rose to 104 degrees and remained at that level for the following two days; the pulse rate was about 140. The patient became irrational, toxic, and suffered acutely whenever the leg or the bed was touched.

During the subsequent eight days the temperature "spiked" between 99.3 and 103 degrees, and the pulse varied from 85 to 130. The patient's general condition improved, the toxaemia subsided, and the intensity of the pain diminished. Further roentgenographic studies (Fig. 2), made on July 24, 1937, showed an increase in the area of rarefaction in the metaphysis. The lateral view revealed a break in the anterior aspect of the cortex.

On August 1, 1937, it became evident that the patient was suffering from an acute osteomyelitis of the fibula, and he was transferred to the Surgical Service. In view of the diminution of toxaemia, general improvement of the patient, and the location of the disease, it was thought that surgery was not imperative, and therefore expectant treatment was continued.

The limb was immobilized in a circular plaster-of-Paris bandage, and periodic roentgenographic studies were made. The plaster-of-Paris support was continued for a period of eight months, during the latter part of which the patient was permitted to bear weight.

The temperature gradually subsided, so that, at the end of two months from the time of onset, it ranged within normal limits. The blood picture gradually approached normal, save for an anaemia which necessitated a transfusion of 250 cubic centimeters of blood during the seventh week of the illness (August 31, 1937).

An observation worthy of note was made on the occasion of the first change of the plaster-of-Paris support during the fourth week of the illness. Active dorsiflexion of the foot was absent, and the ankle jerk could not be elicited. At the same time it was noted that the leg was swollen two and one-half inches. No definite fluctuation could be demonstrated. Nevertheless, expectant treatment was continued, and on the occasion of the next change of plaster support, the neurological signs were absent. All support was discontinued on April 1, 1938.

The most recent examination, February 8, 1941, revealed slight local heat over the head of the fibula, and one-eighth of an inch thickening of the left leg at the involved level. There was no limp, no evidence of palsy, and a complete range of motion in all the joints of the extremity. At no time was there any evidence of a metastatic lesion.

## ROENTGENOGRAPHIC FINDINGS

The periodic roentgenographic studies are most instructive, because of the unusual demonstration of pathological changes in the surgically undisturbed progress of the disease. On the roentgenogram (Fig. 3) of August 13, 1937, there was an evident extensive destruction of the proximal four inches of the fibula, with little periosteal reaction, save at the most distal portion of the lesion.

On the roentgenogram (Fig. 4) of October 26, 1937, the destruction of the proximal four inches of the fibula was practically complete. The associated ossified bulging periosteum could be visualized.

Roentgenographic examination (Fig. 5) made on April 1, 1938, showed that reformation of the fibula had begun. The medullary canal was beginning to reappear at the distal portion of the involved area.

Roentgenographic examination (Fig. 6) made on August 25, 1938, showed increasing reformation of the fibular shaft. The periosteal shadow was more closely approaching the fibula.

Roentgenographic examination (Fig. 7) made on September 14, 1940, showed an almost complete reformation of the shaft of the fibula. The outline of the involved portion of the shaft was somewhat irregular. There were no areas of rarefaction which would be suggestive of active disease.

# "STRAIN" THROMBOSIS OF THE AXILLARY VEIN

BY HAROLD H. COHEN, M.D., NEW YORK, N. Y.

*From the Hospital for Joint Diseases, New York* *

The case herewith presented is typical of a clinical entity first clearly recognized by von Schrötter in 1884, and should be distinguished from thrombosis or thrombophlebitis caused by direct external injury. In this country, it was not until 1931 that Clute reported the first two cases. This was soon followed by a rapid succession of case reports by Matas, Barker, Kaplan, etc. The lesion is predominantly a disease of the right arm of young, robust, hard-working males. It comes on rather acutely either immediately or a few hours after some sudden strain of the arm, or after physical effort or exercise which may be unusually severe or of an unusual type. In some cases a history of indirect trauma cannot be elicited.

## CASE REPORT

G. S., male, aged twenty-seven, was first seen on November 1, 1940, when the following history was obtained: On June 27, 1939, while demolishing the balcony of a theater, the reinforcement wires were cut, and the patient dropped about thirty feet to the ground. There was no loss of consciousness, and he was admitted by ambulance to a city hospital where he remained for two weeks. Four days after admission, black-and-blue spots appeared over the back of his right hand, elbow, and along the arm. Eleven days after the accident, he noted a prominence of the veins about the forearm and shoulder. Swelling was not a prominent feature and was present to only a slight extent. Roentgenographic examination of the entire skeleton revealed a fissure fracture of the body of the right scapula, and a fracture of the left transverse process of the first lumbar vertebra. The patient refused further hospital care and sought a private physician, who admitted him to another hospital. No treatment other than bed rest and physical therapy to the back and lower extremities was administered. On August 10, approximately six weeks after

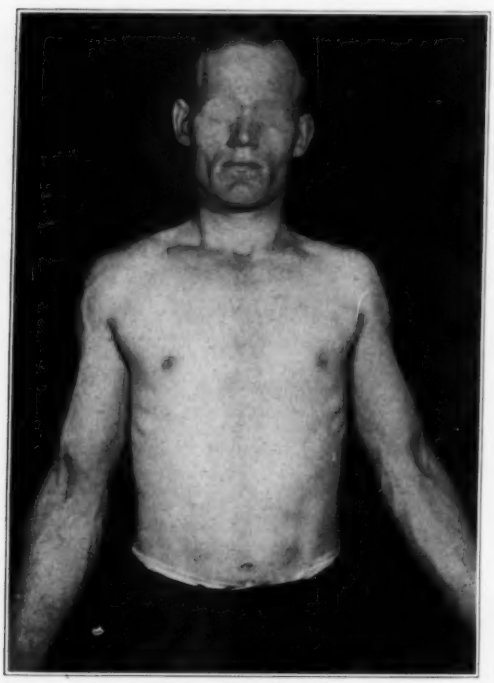

FIG. 1

Comparative size of the arms, the right being larger than the left.

* Service of Samuel Kleinberg, M.D.

the fall, a dull pain developed in the right arm pit, and the man complained of the presence of a tender kernel-like mass in the axilla. This was accompanied by radiating knifelike pains down the arm to the hand. Attacks of numbness, lasting up to five minutes, were first noted ten to eleven weeks after the accident. The attacks of numbness came on by day or night, and were relieved temporarily by change of arm position. At about the same time, a sensation of heaviness was noted in the entire right arm. "Knotting" of the veins was noted approximately eight months after the accident. With laborious work, the patient noted that the attacks of numbness became more frequent and severe, and he was finally forced to discontinue heavy manual labor. The com-

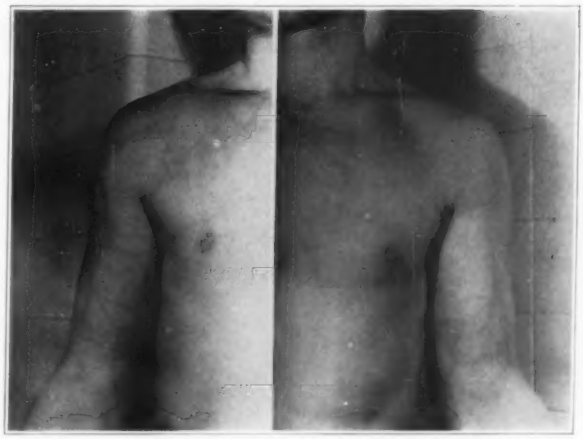

FIG. 2

Infra-red photography shows numerous prominent veins over the right arm, shoulder region, and chest.

FIG. 3

Roentgenogram taken immediately after the injection of ten cubic centimeters of diodrast into the cephalic vein. The vein bifurcates at the upper third of the humerus, and then joins with many dilated collaterals in the supraclavicular and infraclavicular regions.

plaints referable to the head, spine, and genito-urinary systems are irrelevant to the topic under discussion and will therefore be omitted.

*Past history* revealed a severe burn to the right thigh and hip regions at the age of three and one-half years. There was no history of any constitutional illness or previous trauma. He denied having had lues, but a history of a Neisserian infection five years previously was obtained.

*Examination* disclosed an enlargement of the right upper extremity from the shoulder girdle down to the tips of the fingers (Fig. 1). The measurements were as follows:

| | Right | Left |
|---|---|---|
| At junction of arm and shoulder | 12¾ inches | 11¾ inches |
| At mid arm | 12¼ inches | 11½ inches |
| At the elbow | 10 inches | 10 inches |
| At the mid forearm | 11¼ inches | 10⅜ inches |
| At the wrist | 7⅜ inches | 7 inches |

There was marked prominence of the superficial veins extending up to the anterior chest and axilla, as well as along the inner and front side of the arm, forearm, and wrist (Fig. 2). There was a ruborlike tint to the right arm. Elevation of the arm resulted in slow collapse of the dilated veins. With depression these filled rapidly. There was no evidence of palmar ischaemia or clubbing of the fingers of the right hand. The grip of the right hand was considerably weaker than that of the left. No tender cord was to be felt in the axilla. The pulses seemed to be of equal rate, rhythm, and volume. The right arm was colder to the touch. Glands were palpable in both axillae. The

FIG. 4

Roentgenogram taken several minutes after Fig. 3. The dye is still present in the cephalic vein and its inner bifurcation. The dilated veins in the supraclavicular and infraclavicular areas are still to be seen.

FIG. 5

Roentgenogram taken immediately after the injection of ten cubic centimeters of diodrast into the basilic vein. The vein terminates at the middle of the humerus and then loops downward. The axillary vein is not visualized. Numerous fine collaterals are to be seen crossing the humerus to reach the lateral aspect of the arm.

reflexes were not impaired, and there were no sensory disturbances to hot or cold, pinprick, or cotton wool.

Roentgenographic examination of the chest failed to reveal any evidence of cardiac, mediastinal, or pulmonary pathology. Examination of the lower cervical region failed to reveal any evidence of any growth, or cervical rib.

*Laboratory findings* were as follows:

Blood Wassermann—negative
Kahn test—negative
Red blood cells—4,750,000
Hemoglobin—94 per cent.
Platelets—250,000
White blood cells—10,700
Polymorphonuclear neutrophiles—86 per cent.
Lymphocytes—14 per cent.
Bleeding and coagulation times—within normal limits
Sedimentation rate—6 millimeters in 45 minutes

The blood pressure on the affected side was slightly lower than on the left side,—the right was 105 systolic and 70 diastolic, and the left was 110 systolic and 70 diastolic millimeters

of mercury. The oscillometric index paralleling the blood pressure readings showed a definite diminution on the right as compared with the left. The mid-humeral was 9 on the right and 11 on the left, and the wrist was 4 on the right and 4½ on the left. On the contrary, the venous pressure in the right cephalic vein was elevated to 230 millimeters of water (Normal is 60 to 120 millimeters). The circulation time using ten cubic centimeters of calcium gluconate was nineteen seconds (Normal is 10 to 12 seconds). Skin temperatures measured by the electric potentiometer were definitely lower on the right side, the difference varying from 0.5 degrees to 1.2 degrees centigrade.

*Examination* of the right arm, pectoral, cervical, and thoracic regions after the injection of ten cubic centimeters of diodrast into the brachiocephalic vein revealed the dye in the vein on the outer aspect of the arm (Fig. 3). A second x-ray taken almost immediately after the first exposure revealed the dye to be present in a segment of the cephalic vein and also faintly visible in the superficial vein on the outer aspect of the shoulder, as well as in the jugular region and in spots infraclavicularly (Fig. 4). Ten cubic centimeters of diodrast injected into the basilic vein revealed the basilic vein up to about the junction of the lower and middle thirds of the humerus. The basilic was narrowed and not seen in the upper arm, nor was its continuation into the axillary vein seen (Fig. 5).

Though the vein was not actually visualized surgically, the history of an accident with probably indirect trauma to the axillary vein, the enlargement of the arm, the prominence of the superficial veins of the arm and anterior pectoral region, the increased number of superficial veins noted clinically and revealed by infra-red photography, the increased venous pressure, the prolonged circulation time, and the diodrast injection established a diagnosis of thrombosis of the axillary vein.

*The etiology* of axillary thrombosis following indirect trauma is still obscure, despite the theories advanced to account for it. There is no evidence to support the theory of an infectious or toxic lesion of the vein, and the absence of any reported changes in the clotting mechanism of the blood would appear to rule that out as a factor in the thrombosis. Most observers agree that thrombosis follows indirect trauma to the vein,—such as a shoulder strain. This may come from an abduction, extension, or rotary injury of the arm. Such an accident may be of sudden or more gradual onset. The so-called idiopathic cases are believed to be the result of recurrent minimal trauma which is unnoticed by the patient. This trauma was first believed to be a sudden stretching or compression of the distended vein, and more recently has been regarded as a contusion of the vein over the first rib by the subclavius and costocoracoid ligament. Gould and Patey feel that the subclavius causes a rupture of a delicate valve at the level of the muscle. This rupture, according to them, is the fundamental basis for the thrombosis. Several cases have been reported in which, at operation, only a spastic vein was found. The sympathetic theory, advanced by Cottalorda of Marseille (1932), was based on just such a pathological finding at operation. This author feels that the lesion has its origin in a venospasm, induced by sympathetic irritation caused by trauma. Thrombosis may or may not follow. Matas feels that the thrombosis is a complex syndrome of multiple causation in which indirect trauma of the axillary vein, with its surrounding lymphatics and sympathetic plexus, plays the leading rôle.

*Prognosis:* This is good with regard to life. The duration of the disability is variable; there may be a complete return of function in several months, but, in the majority, the convalescence is prolonged, lasting many months. Recurrent attacks of oedema, weakness, and stiffness may follow prolonged exertion, so that these patients do best with change of occupation. Recovery indicates adequate collateral circulation with possible canalization of the thrombus.

*Treatment:* In the majority of cases the patients have been relieved during the acute stage by rest, bandaging, elevation, leeches, physical therapy, and other methods of local care applied in the treatment of phlebitis. Some authors have advised thrombectomy or excision of the entire segment of the spastic vein, when found. In the case here presented, no treatment other than a change of occupation was found necessary.

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# FRACTURE-DISLOCATION OF THE HIP

BY VERNON L. HART, M.D., MINNEAPOLIS, MINNESOTA
*University of Minnesota Medical School*

Watson-Jones [1] states: "Sixteen dislocations of the hip have been associated with fracture of the neck of the femur. After such an injury, operative reduction must inevitably cause necrosis of the detached head. It is better, therefore, if manipulative reduction has failed, to excise the loose head and, after downward displacement of the trochanter, to place the neck of the femur in the joint as in a Whitman reconstruction operation."

The author wishes to report an additional case which was treated by open operation as advised by Watson-Jones. Three years after operation, examination demonstrated a most gratifying functional result with bony ankylosis of the hip.

B. W., male, aged forty-six, was injured seriously in an unusual accident on October 24, 1938. He was horseback riding when the door handle of an automobile passing at considerable speed in the opposite direction caught in the right stirrup. When the ambulance arrived, the physician found the patient unconscious and in profound shock, with a compound fracture of the right patella and a major injury of the right hip.

FIG. 1

Roentgenogram on November 22, 1938, demonstrating complete fracture through the neck of the femur (upper arrow) and complete dislocation of the head of the femur from the acetabulum (lower arrow). There is also evidence of arteriosclerosis and organization of hematoma near the socket.

The author first examined the patient on the following day. He was then conscious, mentally clear, and free from any evidence of shock. On the same day the author treated the compound fracture of the patella by débridement, mechanical cleansing, excision of the entire fragmented patella, suture of the capsule, and primary closure of the wound. The extremity was suspended in traction by means of a Hodgen splint. There was no postoperative infection of the wound.

Examination of the right hip revealed a tremendous hematoma involving the entire hip region and upper thigh. There was two inches of shortening of the extremity. There was no paralysis. Roentgenographic studies (Figs. 1 and 2) on November 22, 1938 revealed a complete fracture through the neck of the femur, and a complete dislocation of the head of the femur from the acetabulum.

Thirty-one days after injury, the fracture-dislocation of the hip was treated by open operation. The hip joint was exposed through the Watson-Jones anterolateral approach. The femoral head, which

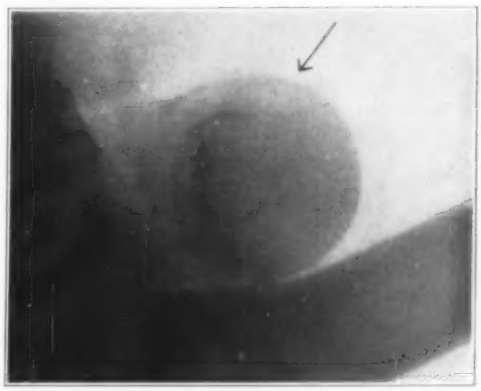

FIG. 2

Lateral roentgenogram on November 22, 1938, showing the head of the femur dislocated downward and anteromedial to the femoral shaft.

FIG. 3

Roentgenogram on October 18, 1941, three years after surgical removal of the femoral head and Whitman reconstruction operation. There is evidence of bony ankylosis of the hip joint, resulting from calcification and ossification of hematoma and articular damage.

was displaced downward and anteromedial to the femoral shaft, was removed from the wound. A Whitman reconstruction procedure was then done. There was considerable evidence of the extensive hematoma within and about all soft-tissue structures. After primary closure of the wound, the hip was splinted in a short plaster spica in 30 degrees of abduction and 15 degrees of flexion. There were no complications, and the patient was discharged, walking with crutches and spica, on December 19, 1938.

Ankylosis of the hip in a good functional position was noted when the hip spica was removed. Ankylosis resulted from calcification and ossification of the extensive hematoma and injury to the articular cartilage of the acetabulum.

The patient returned to his work as a foreman in a power company in the spring of 1939, and has worked continuously since then without pain or complaints. He was last examined by the author on October 18, 1941, when he walked without any form of support and with a good gait. Roentgenographic studies (Fig. 3) and clinical examination demonstrated solid bony ankylosis of the hip in a good functional position with 15 degrees of abduction, 20 degrees of flexion, and slight external rotation.

1. Watson-Jones, R.: Fractures and Other Bone and Joint Injuries. Ed. 2, p. 463. Baltimore, Williams & Wilkins Co., 1941.

# THE USE OF THE CAMPBELL-BOYD PNEUMATIC TOURNIQUET FOR SPINE-FUSION PROCEDURES

BY LOUIS W. BRECK, M.D., AND W. COMPERE BASOM, M.D., EL PASO, TEXAS

In those spine-fusion procedures in which a tibial graft is used, considerable hemorrhage often occurs during the removal of the graft. Even if bleeding is controlled with hemostatic forceps or clamps, there is a definite loss of blood and time, which can be eliminated by the use of a tourniquet on the extremity. The ordinary type of tourniquet is not suitable, because it must be applied at the beginning of the operation and cannot be released when the work on the extremity is finished, without disturbing the drapes.

For the past year, one of the authors has used the Campbell-Boyd pneumatic tourniquet [1] in all spine-fusion procedures in which a tibial graft was necessary. This apparatus consists of a cloth-covered rubber cuff, similar to that of a sphygmomanometer, which can be buckled in place on the extremity. The zipper has been replaced with buckles because they are more reliable. A heavy rubber tubing, which is long enough to reach to the head of the operating table, connects the cuff with a pump and pressure gauge. The cuff of the tourniquet can be buckled in place before the anaesthetizing is begun. The tubing is placed alongside the patient, and the gauge and pump are fastened at the head of the table where the anaesthetist can easily control the pressure. The patient is then anaesthetized, prepared, and draped. The operative procedure may be started at any time on the leg. The anaesthetist can easily inflate the tourniquet to the desired pressure to secure adequate hemostasis. As soon as the surgery is completed on the extremity, the pressure can be released simply by opening a small valve on the manometer. Thus the tourniquet has to be used only during the actual removal of the graft and not for the total time of the spine-fusion procedure.

The disadvantages of this use of the tourniquet are as follows:

It is necessary to have two different lengths of tourniquets to fit the various sizes of extremities, though this item has been found unimportant.

There is also the possibility of a tourniquet paralysis. However, with the application of a correctly determined, exact amount of pressure distributed evenly over a large area, this complication is a negligible factor. Ordinarily six pounds of pressure is used for the small children, nine pounds for larger children, and twelve pounds for adults.

Advantages of this tourniquet are as follows:

Exact amount of pressure may be applied evenly over a large area.

The tourniquet may be easily inflated and quickly deflated at any time without disturbing the sterile surgical drapes or the operator.

There is no blood loss during the removal of the tibial graft, and the tendency toward shock is lessened because of this.

1. CAMPBELL, W. C., AND BOYD, H. B.: A Pneumatic Tourniquet. J. Bone and Joint Surg., XIX, 832, July 1937.

# RUBBER-SURFACE SKIN TRACTION

BY HAMILTON I. BARNARD, M.D., DENVER, COLORADO

This method of traction is not meant to replace simple adhesive traction in the usual type of cases. However, it is found very advantageous in cases where adhesive traction is found inadequate or unsatisfactory, especially where there is skin irritation or where, as in the convalescent stage of infantile paralysis, it is necessary to remove the traction daily for the purpose of physical therapy. As the illustrations show, the method of application is the same as for ordinary adhesive traction.

Figure 1 shows the materials used,—that is, adhesive straps with sponge rubber attached, elastic roller bandage, foot plate, weights, weight holder, and rope. The adhesive straps with webbing attached are cut to the right size. Sponge rubber three-eighths of an inch thick is cut the same size as the adhesive straps and is applied to the adhesive, or the sponge rubber may be glued to plain webbing straps. The skin may or may not be painted with compound tincture of benzoin. The straps are then placed against the extremity as shown in Figure 2, and are held in position by some type of a roller elastic bandage. (See Figure 3.) The rubber comes down well over the malleoli.

This type of traction can be used on either the lower or the upper extremity, and in all types of cases. It can be easily and quickly ad-

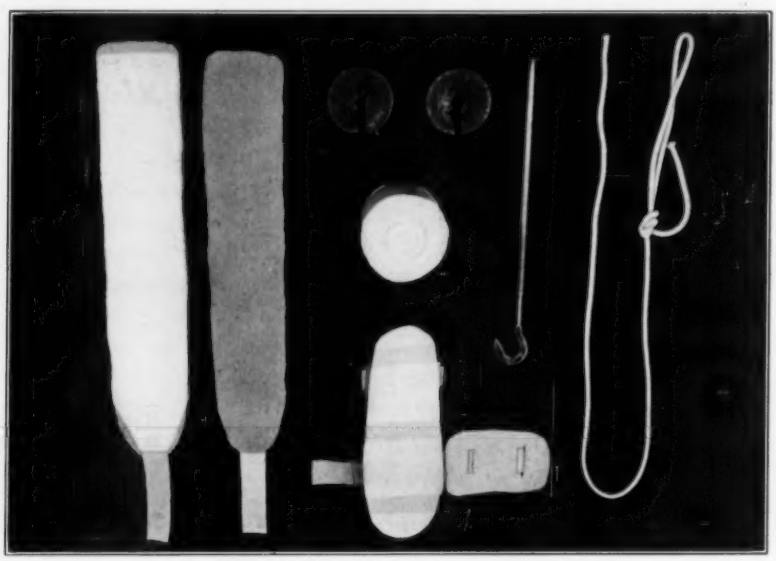

FIG. 1

Material used for rubber-surface skin traction: adhesive straps with sponge rubber attached, foot plate, roller bandage, weights, weight holder, and rope.

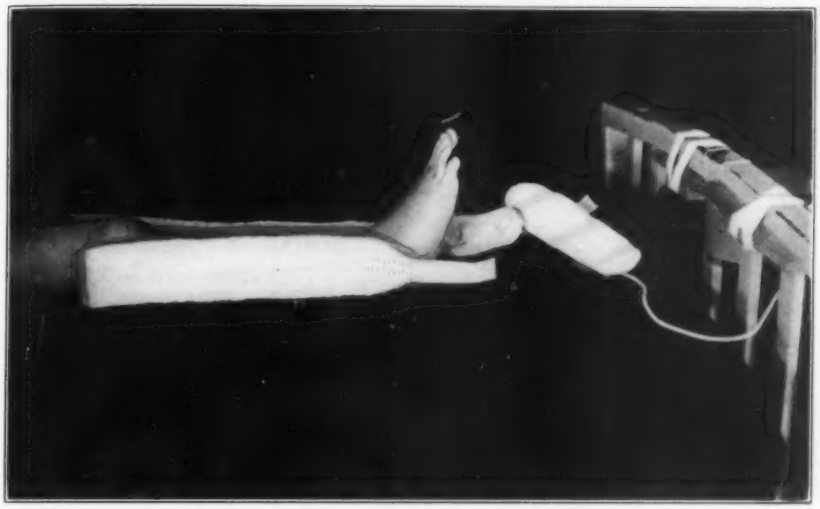

FIG. 2
Straps are placed against the leg in the proper position.

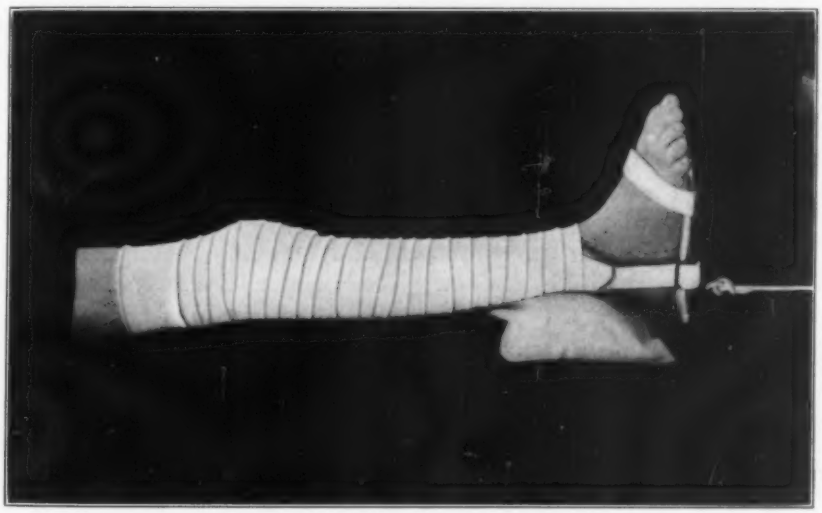

FIG. 3
Traction is completed with the foot plate attached.

justed. On the lower extremity, as much as twenty pounds can be applied with very little slipping. It is also desirable to have a long foot plate or spreader which can be adjusted for different leverages on the foot.

The advantages of this traction are: The adhesive tape can be eliminated entirely; the sponge straps can be used over and over after proper cleansing and they can be removed daily for physical therapy; there is not the irritation of the skin that is often found in adhesive traction; and this type of traction is readily adjusted.

# A NEW MARKER FOR SPINE SURGERY

BY JOSEPH D. WASSERSUG, M.D., SOUTH BRAINTREE, MASSACHUSETTS

*From the Lakeville State Sanatorium, Middleboro, Massachusetts*

In practically all operations upon the spine it is necessary to identify accurately the vertebral bodies that are being operated upon. Skin markers, such as silver nitrate, are inadequate because they may become effaced when the back is prepared for operation. Besides, such markers are concealed when the skin edges of the operative wound are covered by towels. Another type of marker recently used in some hospitals is a needle that is inserted preoperatively into the spinous process and then broken off. Although this method gives accurate visual and roentgenographic localization of the site of operation, it is not without some hazard.

Recently Betts, and Overholt and Rumel described the use of a mixture of lipiodol and carbon which is injected into an intercostal muscle, thus providing roentgenographic localization and a visual landmark in operations for pulmonary abscess. Lipiodol and lampblack were used after other combinations of radiopaque and easily visualized materials were tested and found to be less satisfactory.

Modifying the technique described by them, two to three minims of a one-per-cent. suspension of lampblack in lipiodol (40 per cent. iodine) is injected subcutaneously over the spinous process that is to serve as the landmark. The lipiodol and lampblack mixture is autoclaved once, and if proper precautions are employed, may remain sterile indefinitely. To insure a uniform distribution of carbon particles it is advisable to shake the mixture just before using. A hypodermic syringe or a tuberculin syringe and a 22- or 23-gauge needle, one and one-half inches long, are used. It is not necessary to anaesthetize the site of injection with procaine, but this may be done optionally.

The spinous process that is to serve as a landmark is localized by palpation under aseptic precautions and the needle is inserted, until it is felt to touch the spinous process, when it is slightly withdrawn and the lipiodol and carbon mixture is injected. Two to three minims of mixture is all that is necessary, and care must be taken to see that larger quantities are not used, since it is not advisable to have the material diffuse over too great an area. Roentgenograms are then taken. The lipiodol can be seen on the roentgenograms, and the lampblack shows up clearly at the time of operation.

This technique has been successfully carried out on fifteen patients. The ages of the patients varied from six to forty-eight years, and there were ten females and five males in the series. Twelve patients had tuberculosis of the spine, and the lipiodol and carbon markers were used in preparation for an arthrodesis. The three remaining patients had

infantile paralysis. One of these had a scoliotic spine, and the lipiodol and carbon mixture was injected to serve as a landmark for a spine fusion. The other two patients had a pseudarthrosis following a spine arthrodesis for scoliosis. The lipiodol and carbon were used as markers for the pseudarthrosis and a successful repair was later carried out.

The time between injection of lipiodol and carbon and the operation varied from three to fourteen days. In all but one case the carbon was recognized easily at operation. In only one case was it necessary to inject the patient twice because too small a quantity to permit roentgenographic visualization had first been used. In no case did infection or inflammation develop at the site of the injection either preoperatively or postoperatively. An occasional patient has complained of a slight amount of pain following injection, but this was readily controlled by aspirin.

## SUMMARY

A one-per-cent. suspension of lampblack in lipiodol, injected subcutaneously and intramuscularly, is a safe and convenient marker for operations on the spine. It combines accurate roentgenographic localization with ready visualization at the time of operation.

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# News Notes

The **American Association of Industrial Physicians and Surgeons** and the **American Industrial Hygiene Association** will hold their joint Annual Convention in Cincinnati, April 13 to 17, 1942.

**The American Physiotherapy Association** will hold its Twenty-First Annual Convention at Lake Geneva, Wisconsin, June 28 to July 3, 1942.

The dedication of the new Professional Service Building at the **Hospital for Joint Diseases,** New York (the Melanie Faith Polachek Cournand Memorial), took place on Saturday, February 7. This building will be a valuable addition to the Hospital.

Dr. Julius Hass, who formerly occupied the Chair of Orthopaedic Surgery at the University of Vienna, has been appointed Attending Orthopaedic Surgeon, in charge of the Orthopaedic Service, at Montefiore Hospital, New York City.

Dr. Luthero Vargas, eldest son of the President of Brazil, is in this country on a mission from the municipality of Rio de Janeiro, to study and investigate methods of North American hospitals with a view to establishing in that city a charity wing of 100 beds, exclusively for the treatment of school children. This is to be connected with the Centro Medico Pedagogico "Oswaldo Cruz", of which Dr. Vargas is chief surgeon in the orthopaedic department.

Extra copies of "Progress in Orthopaedic Surgery for 1940", published in the September, October, and November 1941 numbers of *Archives of Surgery,* are available at $1.00 per copy, from the office of the Editor, Box 269, Wilmington, Delaware. This is a most comprehensive review of the orthopaedic literature for the year 1940.

A small group of orthopaedic surgeons of Eastern New York State and Western New England have recently formed a local orthopaedic group. They have chosen for the name of their organization, **"The Nicholas André Society",** for André, who in 1741 first used the term "orthopaedia". Meetings are held once a month at the offices or homes of the members. At each meeting, the host may demonstrate patients, offer a scientific presentation, or lead a round-table discussion of an announced subject. The scientific program is followed by a social hour.

Because of the war, the Thirty-Second Annual Clinical Congress of the **American College of Surgeons** will be held in Chicago, October 19 to 23, 1942, instead of in Los Angeles as originally planned. Headquarters will be at the Stevens Hotel. The Twenty-Fifth Annual Hospital Standardization Conference, sponsored by the College, will be held simultaneously. The programs of both meetings will be based chiefly on wartime activities as they affect surgeons and hospital personnel in military and civilian service.

## CONSERVATION OF MEDICAL JOURNALS

The American Library Association created this last year the Committee on Aid to Libraries in War Areas, headed by John R. Russell, the Librarian of the University of Rochester. The Committee is faced with numerous serious problems, and hopes that American scholars and scientists will be of considerable aid in the solution of some of these problems.

One of the most difficult tasks in library reconstruction after the first World War was that of completing foreign institutional sets of American scholarly, scientific, and technical periodicals. The attempt to avoid a duplication of that situation is now the concern of the Committee.

Many sets of journals will be broken by the financial inability of the institutions to renew subscriptions. As far as possible they will be completed from a stock of periodicals being purchased by the Committee. Many more will have been broken through mail difficulties and loss of shipments, while still other sets will have disappeared in the destruction of libraries. The size of the eventual demand is impossible to estimate, but requests already received by the Committee give evidence that it will be enormous.

In view of an imminent paper shortage, attempts are being made to collect old periodicals for pulp. Fearing this possible reduction in the already limited supply of scholarly and scientific journals, the Committee hopes to enlist the cooperation of subscribers to this Journal in preventing the sacrifice of this type of material to the demand for pulp.

It is scarcely necessary to mention the appreciation of foreign institutions and scholars for the activity of the Association in meeting this need.

Questions concerning the project or concerning the value of particular periodicals to the project should be directed to Wayne M. Hartwell, Executive Assistant to the Committee on Aid to Libraries in War Areas, Rush Rhees Library, University of Rochester, Rochester, New York.

## THE AMERICAN ORTHOPAEDIC ASSOCIATION

The Fifty-Sixth Annual Meeting of **The American Orthopaedic Association** will be held at Baltimore and Virginia Beach, June 3 through June 5, 1942, under the presidency of Dr. George E. Bennett. Present plans are for the meeting on June 3 to be held in Baltimore, the members and guests leaving that evening by chartered boat for Virginia Beach where the scientific and executive sessions will be held on Thursday and Friday, at the Cavalier Hotel. The party will return to Baltimore by boat on Friday night. Should circumstances make the boat trip inadvisable, the entire meeting will be held in Baltimore.

The tentative program as submitted by the Program Committee is as follows:

### Wednesday, June 3, Baltimore

*Morning Session*

Clinical presentation by Dr. George E. Bennett and Associates.

*Noon*

First Executive Session.

*Afternoon Session*

War Surgery.

Col. J. A. MacFarlane, Surgical Consultant to Canadian Active Service Force.

Pin Fixation of War Fractures.

Dr. Wallace H. Cole, St. Paul, Minnesota.

Report by Dr. Guy W. Leadbetter, Washington, D. C., Chairman of Combined Military Committees of The American Orthopaedic Association and The American Academy of Orthopaedic Surgeons.

Metal Internal Fixation in Lumbosacral Fusion.

Dr. Philip D. Wilson, New York, N. Y.

Indications for the Intravenous Use of Amino Acid Mixtures in Surgery.

Dr. Lee E. Farr, Director of Research of the Alfred I. duPont Institute of the Nemours Foundation. (By invitation.)

THURSDAY, JUNE 4, VIRGINIA BEACH

*Morning Session*

End Results of Treatment of Poliomyelitis in Baltimore.
Dr. George E. Bennett, Baltimore, Maryland.
Dr. R. E. Lenhard, Baltimore, Maryland. (By invitation.)

End Results of Treatment of Poliomyelitis in Detroit.
Dr. Charles W. Peabody, Detroit, Michigan.

End Results of Treatment of Poliomyelitis in Toronto.
Dr. W. J. Gardiner, Toronto, Ontario, Canada. (By invitation.)

Departures from the Principles of Absolute Fixation in the Treatment of Anterior Poliomyelitis.
Dr. Arthur Steindler, Iowa City, Iowa.

Spasticity of Muscles in Anterior Poliomyelitis.
Dr. R. Plato Schwartz, Rochester, New York.
Discussion opened by Dr. Wallace H. Cole and Dr. Frank R. Ober.

A Method of Measuring Strength of Trunk Muscles.
Dr. Leo Mayer, New York, N. Y.

Arthrodesis of the Paralytic Shoulder.
Dr. Paul C. Colonna, Oklahoma City, Oklahoma (for Dr. Joseph S. Barr, Boston, Massachusetts, Chairman of the Research Committee).

Arthrodesis of the Wrist Joint.
Dr. LeRoy C. Abbott, San Francisco, California.

Post-Metastatic Survival of Osteogenic Sarcoma.
Dr. Kellogg Speed, Chicago, Illinois.

*Afternoon*

Annual Golf Tournament.

*Evening*

Annual Dinner.

FRIDAY, JUNE 5, VIRGINIA BEACH

*Morning Session*

Compound Fractures.
Dr. Arthur G. Davis, Erie, Pennsylvania.

Spondylolisthesis.
Dr. Henry W. Meyerding, Rochester, Minnesota.
Discussion opened by Dr. R. I. Harris.

Congenital Dislocation of the Hip.
Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Spontaneous Fracture of the Femur Following Radiation Therapy for Pelvic Malignancy.
Dr. Carl E. Badgley, Ann Arbor, Michigan.
Discussion opened by Dr. W. E. Gallie.

The Healing of Fractures.
Dr. Robert W. Johnson, Jr., Baltimore, Maryland.
Dr. Marshall R. Urist, Baltimore, Maryland. (By invitation.)
Discussion opened by Dr. J. Albert Key.

Malignant Vascular Tumors of Bone.
Dr. Atha Thomas, Denver, Colorado.
Discussion opened by Dr. Dallas B. Phemister.

*Noon*

Second Executive Session.

*Afternoon Session*

President's Address.
Dr. George E. Bennett, Baltimore, Maryland.
Osteomyelitis and Its Treatment by Sulfonamide Drugs.
Dr. John C. Wilson, Los Angeles, California.
Fracture of the Odontoid Process.
Dr. W. E. Gallie, Toronto, Ontario, Canada.
The Use of Steel Wires for Retention of Bone Fragments.
Dr. A. W. Farmer, Toronto, Ontario, Canada. (By invitation.)
Etiology of Aseptic Necrosis of the Head of the Femur Following Fracture.
Dr. Edward L. Compere, Chicago, Illinois.
Discussion opened by Dr. Dallas B. Phemister and Dr. J. Albert Key.
An Operation for the Correction of Acromioclavicular Dislocation.
Dr. Luthero Vargas, Rio de Janeiro, Brazil. (By invitation.)
Local Anaesthesia in Spine Surgery.
Dr. Joseph A. Freiberg, Cincinnati, Ohio.
Discussion opened by Dr. J. H. Kite and Dr. Ralph K. Ghormley.

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## THE AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS

The Tenth Annual Convention of **The American Academy of Orthopaedic Surgeons** was held at the Chalfonte-Haddon Hall Hotel, Atlantic City, New Jersey, January 11, 12, 13, 14, and 15, 1942, under the presidency of Dr. Oscar Lee Miller, of Charlotte, North Carolina. The meeting was one of the most successful, with a registration of over 800. The instructional courses proved exceptionally interesting and popular, and it was decided that similar courses should be a feature of the 1943 meeting.

The scientific program included the following papers:

### Monday, January 12

*Morning Session*

Two Cases of Late Rupture of the Extensor Pollicis Longus Tendon Following Colles' Fracture—Dr. Edwin Weinberg, Baltimore, Maryland.
The Steinmann Pin in Fracture Fixation—Dr. O. Anderson Engh, Washington, D. C.
A Report of Thirty Cases of Osteochondritis Dissecans—Lt. Comdr. Robert Mazet, Jr., U.S.N.
The Army Medical Corps—Col. George Lull, U.S.A. (By invitation.)
The Clinical Use of the Chamberlain Technique in Back Examinations—Dr. Randolph L. Anderson, Charleston, West Virginia.
Vitallium Replacement of Upper Two-Thirds of Femur, Following Nailing for Non-Union of Neck of Femur, Subsequent Bone Graft for Giant-Cell Tumor, and Finally Resection of Bone—Dr. Austin T. Moore, Columbia, South Carolina.
Congenital Synostosis of the Cervical Spine (Klippel-Feil Syndrome). A Study of Case Reports—Dr. H. Alvan Jones, Baltimore, Maryland.
Two Cases of Interscapulothoracic Amputation—Major Leonard T. Peterson, U.S.A.

*Afternoon Session*

The Treatment of Fracture and Dislocation of the Cervical Spine—Dr. William A. Rogers, Boston, Massachusetts.
Treatment of Flexion Deformities of the Knee—Dr. Rudolph S. Reich, Cleveland, Ohio.
Pathology of Recurrent Dislocation of the Shoulder; Report of Bankhart's Operative Procedure—Dr. Frederick C. Bost and Dr. Verne T. Inman (by invitation), San Francisco, California.

TUESDAY, JANUARY 13

*Morning Session*

Eosinophilic or Solitary Granuloma—Is It a New Disease?—Dr. William T. Green and Dr. Sidney Farber (by invitation), Boston, Massachusetts.

Rate and Amount of Increase in Muscle Strength Following Infantile Paralysis—Dr. Robert L. Carroll, Los Angeles, California.

The Obturator Sign as the Earliest Roentgenographic Evidence of Hip Joint Infection—Dr. Herman C. Schumm, Dr. Vernon C. Turner (by invitation), and Dr. Hans W. Hefke (by invitation), Milwaukee, Wisconsin.

A Study of Gross and Microscopic Lesions in Tuberculosis of the Spine—Dr. Mather Cleveland and Dr. David M. Bosworth, New York, N. Y.

*Afternoon Session*

Prevention of the Hereditary Crippling Diseases—Dr. William Allan, Charlotte, North Carolina. (By invitation.)

Calcification and Ossification of Semilunar Cartilages—Dr. James B. Weaver, Kansas City, Missouri.

The Rôle of Articular Cartilage in Hypertrophic Arthritis—Dr. George Wagoner, Haverford, Pennsylvania.

WEDNESDAY, JANUARY 14

*Morning Session*

What is Actually the Best Treatment of Acute Osteomyelitis?—Dr. Pedro S. Toledo, Havana, Cuba.

Experimental Osteomyelitis—Dr. Philip Lewin and Dr. Louis Scheman (by invitation), Chicago, Illinois.

The Value of the Laminograph in the Treatment of Chronic Osteomyelitis—Dr. Alan DeForest Smith and Dr. Lawson E. Miller (by invitation), New York, N. Y.

The Report of the Use of Sulfonamides in Traumatic and Infected Wounds—Dr. Lenox D. Baker, Durham, North Carolina.

Treatment of Club Feet with Denis Browne Splints—Dr. Stuart A. Thomson, Toronto, Canada. (By invitation.)

*Afternoon Session*

The Management of Associated Injuries in the Presence of Skull Fracture—Dr. Harry E. Mock, Chicago, Illinois.

President's Address—Dr. Oscar Lee Miller, Charlotte, North Carolina.

Fusion of the Metacarpal of the Thumb and Index Finger to Maintain Functional Position of the Thumb—Dr. Charles F. Thompson, Indianapolis, Indiana.

THURSDAY, JANUARY 15

*Morning Session*

Extra-Articular Fixation and Bone-Grafting of Fractures of the Hip. Preliminary Report—Dr. Juan Farill, Mexico City, Mexico.

The Orthopaedic Treatment of Hypertrophic Arthritis of the Hip—Dr. John G. Kuhns, Boston, Massachusetts.

Surgical Treatment of Painful Hips in Adults—Dr. Ralph K. Ghormley and Dr. Mark B. Coventry (by invitation), Rochester, Minnesota.

Further Report on the Kenny Treatment of Infantile Paralysis—Dr. Wallace H. Cole, St. Paul, Minnesota.

An important feature of the program this year was the "refresher" courses which were given on Tuesday and Wednesday mornings and on Monday, Tuesday, and Wednesday afternoons. The subjects of these instructional courses, and the faculty, were:

*Lame Back:* Drs. Ober, Ferguson, Kubik, Chamberlain, Nichols, Brown, Rogers, Hampton, Hansson, Smith, Lewin, Badgley, Steindler, Dickson, and Ghormley.

*Roentgen Therapy:* Dr. Pendergrass.

*Fractures:* Drs. Conwell, Murray, Anderson, McBride, Speed, Johnson, and White.

*Arthritis:* Drs. Swaim, Dickson, Ferguson, Hench, and Shands.

*Knee Joint:* Drs. Bennett, Voshell, Mauck, Bosworth, and Brantigan.

*Vitallium-Mold Arthroplasty:* Dr. Smith-Petersen.

*Bone Metabolism:* Drs. Gill and Stein.

*Surgery of the Hand:* Dr. Bunnell.

*Disability Evaluation:* Dr. Magnuson.

*Foot Disabilities:* Drs. Lewin, Morton, Diveley, Ober, Hauser, McBride, Miller, Hart, Steindler, Barber, Speed, Compere, Schwartz, Kirk, Schrock, Hobart, Phelps, Orr, Sloat, Heyman, Hallock, Freiberg, Shands, and Mayer.

*Scoliosis:* Drs. Smith, Ferguson, Steindler, Cobb, von Lackum, and Risser.

*Bone Tumors:* Drs. Murphy and Ramsey.

*Periarthritis of the Shoulder:* Dr. Dickson.

*War Surgery:* Drs. Cole, Waknitz, and Dial.

*Club Foot and Congenital Deformities:* Dr. Kite.

There were a large number of motion pictures given before and following the scientific sessions. These covered many subjects of interest to the attending surgeons.

The scientific exhibits were of a high order. These were in charge of a committee of which Dr. Julius S. Neviaser, of Washington, D. C., was Chairman.

There were also many commercial exhibits, and Dr. Frank M. Hand was Chairman of the committee in charge.

Dr. J. E. M. Thomson was Chairman of the Program Committee, Dr. Guy W. Leadbetter was Chairman of the Local Arrangements Committee, and Dr. Custis Lee Hall, of the Local Program Committee.

A very enjoyable social program was planned by the President.

After the Annual Banquet, held on Wednesday evening, January 14, in the Chalfonte Dining Room, the following awards were made for scientific exhibits:

Gold medal for Originality of Presentation of Research Problems, to Dr. James B. Weaver and Dr. Mary W. Tyler, of Kansas City, Missouri; Title of exhibit, "Hematogenous Staphylococcic Osteomyelitis. Clinical, Immunological, and Experimental Studies."

Gold medal for Scientific Importance and Information, to Dr. J. T. Murphy and Dr. C. E. Hufford, of Toledo, Ohio; Title of exhibit, "Bone Pathology. Clinical Correlation with Radiological and Pathological Findings."

Gold medal for Clinical Value, to Dr. Walter A. Hoyt and Dr. Adrian Davis, of Akron, Ohio; Title of exhibit, "Acute Osteomyelitis. Non-Operative Treatment by Sulfathiazole."

Certificates of merit were awarded to the following for their exhibits:

Dr. William T. Green and Dr. Sidney Farber, of Boston, Massachusetts—"Eosinophilic or Solitary Granuloma. Is It a New Disease?"

Dr. Vernon L. Hart, of Minneapolis, Minnesota—"Dysplasia of the Hip Joint, With and Without Dislocation".

Dr. William Allan, of Charlotte, North Carolina—"Survey in North Carolina of Hereditary Crippling Diseases". (Miss Pearl Dudley, in charge of Field-Work Exhibits.)

Dr. Mather Cleveland, Dr. David M. Bosworth, and Dr. Sumner Price, of New York, N. Y.—"Tuberculous Pathology of Spine, Gross and Microscopic".

Dr. Roger Anderson, of Seattle, Washington—"Intertrochanteric Fractures and Non-Union of the Neck of the Femur".

Dr. James A. Dickson and Dr. William A. Nosik, of Cleveland, Ohio—"Thorotrast Myelography. Experimental and Clinical Studies".

Certificates of membership were given to the following new Fellows:

Dr. George Thomson Aitken, Grand Rapids, Michigan.
Dr. George Clarence Battalora, New Orleans, Louisiana.
Dr. Harry Archer Berman, Boston, Massachusetts.
Dr. H. H. Boucher, Vancouver, British Columbia.
Dr. Abraham S. Browdie, Pittsburgh, Pennsylvania.
Dr. Alvin Rich Carpenter, Binghamton, New York.
Dr. Eldon George Chuinard, Portland, Oregon.
Dr. William Cooper, Brooklyn, New York.
Dr. Edward G. Ewer, Oakland, California.
Dr. Erasmus D. Fenner, New Orleans, Louisiana.
Dr. Charles H. Frantz, Alexandria, Louisiana.
Dr. John H. Galbraith, Altoona, Pennsylvania.
Dr. Nicholas J. Giannestras, Cincinnati, Ohio.
Dr. Charles W. Gilfillan, Los Angeles, California.
Dr. Wayne R. Glock, Fort Wayne, Indiana.
Dr. George Hammond, Ann Arbor, Michigan.
Dr. John E. Hanby, Washington, D. C.
Dr. Frank C. Hodges, Abilene, Texas.
Capt. F. R. Hook, M.C., U.S.N., Washington, D. C.
Dr. William A. Horan, Providence, Rhode Island.
Dr. Harry C. Hughes, Denver, Colorado.
Dr. Jay L. Hutchison, Huntington, West Virginia.
Dr. Frank S. Jones, Hartford, Connecticut.
Lt. Frank P. Kreuz, Jr., M.C., U.S.N., Quonset Point, Rhode Island.
Dr. Henry B. Lacey, Columbus, Ohio.
Dr. Claude N. Lambert, Chicago, Illinois.
Dr. John F. Lovejoy, Jacksonville, Florida.
Dr. Gilbert J. McKelvey, Portland, Oregon.
Dr. I. S. McReynolds, Houston, Texas.
Dr. Foster Matchett, Denver, Colorado.
Dr. Newton C. Mead, Evanston, Illinois.
Dr. Bernard J. Mintz, New York, N. Y.
Dr. John R. Naden, Vancouver, British Columbia.
Dr. Alonzo J. Neufeld, Los Angeles, California.
Dr. Tom Outland, Harrisburg, Pennsylvania.
Major Leonard T. Peterson, M.C., U.S.A., Washington, D. C.
Dr. Walter R. Peterson, Trenton, New Jersey.
Dr. Edward K. Prigge, Los Angeles, California.
Dr. Victor Raisman, Richmond Hill, New York.
Dr. Maurice B. Roche, St. Louis, Missouri.
Dr. Manley B. Shaw, Boise, Idaho.
Dr. Howard B. Shorbe, Oklahoma City, Oklahoma.
Dr. Lawrence C. Snow, Salt Lake City, Utah.
Dr. Francis E. West, San Diego, California.
Dr. Harry Winkler, Charlotte, North Carolina.
Dr. Charles J. Zinn, Philadelphia, Pennsylvania.

Four doctors were elected to Honorary Membership: Dr. José Valls, Buenos Aires, Argentina; Dr. Herman de las Casas, Caracas, Venezuela; Dr. Eugenio Diaz-Lira, Santiago, Chile, and Dr. William E. Gallie, Toronto, Ontario.

Executive Sessions were held on Monday and on Thursday. At the last Session, the new President, Dr. Carl E. Badgley, was introduced, and new officers were elected.

The officers of the Academy are:

President: Dr. Carl E. Badgley, Ann Arbor, Michigan.
President-Elect: Dr. M. N. Smith-Petersen, Boston, Massachusetts.
Vice-President: Dr. Robert V. Funsten, Charlottesville, Virginia.
Treasurer: Dr. E. Bishop Mumford, Indianapolis, Indiana.
Secretary: Dr. Rex L. Diveley, Kansas City, Missouri.
Librarian-Historian: Dr. Philip Lewin, Chicago, Illinois.

The Palmer House, in Chicago, Illinois, has been selected as the headquarters for the next Annual Meeting, January 17 to 21, 1943.

## THE BRITISH ORTHOPAEDIC ASSOCIATION

**The British Orthopaedic Association** held its Annual Meeting for 1941 in Oxford, on January 2 and 3, 1942. It was attended by a large number of members and visitors, including a good representation from the United States and from Canada. The meeting was opened by the President, Prof. T. P. McMurray, who later handed over the Chair to his successor in office, Mr. G. R. Girdlestone, of Oxford.

During the business session the following officers were elected:

Vice-President: Mr. R. Ollerenshaw, Manchester.
Hon. Treasurer: Mr. B. H. Burns, London.
Hon. Editorial Secretary: Mr. Norman Capener, Exeter.

The following members of the Executive Committee were chosen:

Mr. W. Gissane, Birmingham.
Mr. F. W. Holdsworth, Sheffield.
Mr. B. L. McFarland, Liverpool.

Additional members were elected to the Executive Committee as a wartime measure:

Prof. Harry Platt, Manchester.
Mr. W. Rowley Bristow, London.
Mr. W. A. Cochrane, Edinburgh.
Prof. T. P. McMurray, Liverpool.
Mr. R. Watson-Jones, Liverpool.

Honorary membership in the Association was conferred upon Dr. Philip D. Wilson, of New York.

The following orthopaedic surgeons were elected to Associate membership: Mr. A. E. Burton, Mr. H. M. Coleman, Mr. E. Mervyn Evans, Mr. M. Meekison, Mr. L. S. Michaelis, Mr. G. Parker, Mr. I. Robertson, Mr. Noel Smith, and Mr. R. J. W. Withers.

The following Associate Members were elected to full membership: Mr. A. L. Eyre-Brooke, Mr. A. J. Watson, Mr. H. L. C. Wood, Lt. Col. Ralph Brooke, and Mr. W. C. Somerville-Large.

At the meeting on Friday, January 2, Prof. T. P. McMurray gave his Presidential Address on *Conservatism in Orthopaedic Surgery*. Remarking on the false impression gained from a study of the programs of the Association during the past ten years, he noted that it would appear that orthopaedic surgeons were mainly concerned with the advance and modification of operative technical procedures. He stressed, however, the larger interest in conservative measures devoted to the correction of deformity and improvement of function through splintage and non-operative methods. When performed, operations in orthopaedics are often only a stage in the restoration of function. Orthopaedic surgeons should not let their minds be deflected from these larger questions of

conservatism, which have become so much wider in the past few years, including re-education and rehabilitation of the crippled and injured. The orthopaedic surgeon must be trained in all the methods by which function can be restored. It was because of the broad outlook of certain surgeons in the matters of diagnosis, prevention, and treatment that the specialty of Orthopaedic Surgery was formed. Failure to maintain the traditional outlook of orthopaedics would only encourage the formation of separate groups, who would concern themselves with special non-operative therapeutic departments.

The following papers were presented:

*Arthroplasty of the Hip Joint* by Dr. Philip D. Wilson, New York.

A brief review of the history of this operation was given, and a discussion of the two particular methods now employed: (a) fascial interposition, a procedure in use for twenty years, and (b) the use of vitallium cups, during the past three or four years.

Dr. Wilson reviewed his own group of thirty-nine patients, upon whom forty-five arthroplasties had been performed. Of the operations which had been followed up, twelve were by fascial interposition and twenty-eight by the cup method. The best results in both types were obtained where there was solid bony ankylosis, in which the periarticular scarring and adhesion were less than in fibrous ankylosis. The statistics tended to show a slightly better functional result by the method of fascial interposition, but this was somewhat counterbalanced by the simpler technique and easier postoperative recovery in those patients treated by the cup method. Actually, the poor results with the vitallium cup were largely obtained in the group of arthritic patients in whom it was known that the fascial method would have given poor results, but where it was thought important to learn what might be accomplished by the newer method. The best results in the series were obtained in conditions due to trauma or aseptic necrosis. With the vitallium cup there is a wider range of use established in old, unreduced congenital dislocations. There are many technical difficulties, and the greater the surgeon's experience, the better the results.

*Some Observations on Paget's Disease* by Mr. A. Rocyn Jones, London.

A review was given of the clinical, roentgenographic, histological, and biochemical aspects of this disease, and the help that these studies can give in the diagnosis of osteitis deformans when it affects a single bone.

Fracture in Paget's disease was discussed, with its peculiar transverse character in both complete and incomplete varieties. At a second operation on a patient, made necessary because of the interposition of muscle, some of the callus was removed, and histological study revealed that the healing of the fracture was by normal bone which had none of the characteristic appearance of bone affected by Paget's disease. It is probably because of this fact that fractures in Paget's disease heal so readily.

*Recurrent Dislocation of the Shoulder* by Mr. A. L. Eyre-Brooke, Bristol.

This paper is based upon the study of a shoulder of a patient who had died following an operation for recurrent dislocation of the shoulder by Nicola's technique. Mr. Eyre-Brooke became interested in the problem because of his experience with this case. He demonstrated specimens of normal shoulders, illustrating the attachment of the anterior capsule to the lip of the glenoid cavity, and then showed in the pathological specimen how this attachment was defective.

In his discussion of the conflicting views of the nature of this lesion, he showed how this case supported Bankhart's view that recurrent dislocation of the shoulder was quite different from the usual anterior dislocation, in that it was caused by direct forward dislocation rendered possible by detachment of the capsule from the anterior rim of the glenoid cavity. Bankhart believed in exposing such a lesion at operation. Those who differ with him rarely expose the region of the lesion.

*Bone Grafting of the Fractured Carpal Scaphoid* by Mr. J. R. Armstrong.

The "closed" technique for pegging fractures of the scaphoid was described, its difficulties being due to the oblique position of the bone in all anatomical planes. A padded rest in the form of a right-angled groove, each side of which forms an angle of 45 degrees to the vertical, is used on the operating table to support the forearm and hand with the wrist joint in the neutral position. The dorsum rests downward on one side of this groove, so that the forearm and hand are in the position of 45 degrees short of full supination. The long axis of the scaphoid then lies in the vertical plane at an angle of 50 degrees to the anatomically transverse plane of the wrist. A guide pin is inserted in this line distally from the tubercle, and checked roentgenographically. If correct, a special hollow cutting instrument is passed over the guide. Through the hole is passed an autogenous bone graft obtained from the hard subcutaneous border of the tibia.

Twenty-three patients have been operated upon by this method, of whom thirteen have completed treatment, and show bony union. The average period of immobilization was eighteen weeks, the longest being thirty-one weeks and the shortest, eleven weeks. Eight of the patients have wrists which are functionally indistinguishable from normal; two were not seen after removal of plaster; two were returned to full duty, but complained of slight weakness and pain at extremes of movement, which were slightly limited; and one patient, who showed arthritis before operation, was not benefited, although bony union occurred.

*Ossification about the Elbow Joint* by Mr. Geoffrey Hyman, Leeds.

In this paper a report was given of an investigation upon sixty-seven cases of traumatic ossification about the elbow, which appears most likely to occur following a single severe injury associated with the tearing of ligaments. In almost every case (94 per cent.) tiny, detached flakes of bone were seen soon after injury in the region of the ligamentous attachment, most commonly in those on the collateral and posterior aspects. In the latter, importance was placed on the taking of roentgenograms in the supero-inferior plane, with the joint in flexion.

In the cause of this ossification, apart from the bone flakes, predisposing factors were the delayed, repeated, or violent reductions of dislocation, or faulty after-treatment. Collateral ossification does not appear greatly to limit function; the greatest disability occurs when minute areas of ossification are found apparently close to the joint line anteriorly. In the prevention of such ossification, it is important that dislocations be reduced gently and as soon as possible. When established, immobilization upon a posterior plaster splint at an angle of 70 degrees was the treatment.

In one group (fifteen cases), this treatment was continued until the roentgenograms showed disappearance of the new-bone formation, or the process had become stationary,—generally in about twelve weeks. In the second group (twenty-eight cases), the clinical evidences of subsidence were taken,—the absence of swelling and tenderness, and the possibility of full active flexion without pain. With these, the average period of treatment was three weeks, and the results were at least as good as in the first group.

*Pelvic Dislocation* by Mr. R. G. Taylor, Sheffield.

A review of twenty-two cases of dislocation of the pelvis was reported, the type of case being that in which dislocation of the symphysis pubis of severe degree was accompanied by subluxation at the sacro-iliac joint. At Sheffield Royal Infirmary, out of a total of 13,500 fractures, there were seventy-three fractures of the pelvis and thirteen pelvic dislocations. The generally stated view that such dislocations are produced by direct anteroposterior violence was shown to be incorrect, and that they are in fact due to indirect violence applied to the hindquarter by either hyperextension or hyperabduction of the lower limb on the trunk, the former being the more common. Attempts to join the pubic bones by operative interference were shown to be useless. Two forms of treatment were advised: (1) that described by Watson-Jones, in which the patient is placed in the lateral position upon the sound side so that the dislocated half of the pelvis folds

forward into position, with the reduction maintained in plaster until the pelvic ligaments have healed; or (2) that described originally by Sir Astley Cooper, in which a sling is used, so arranged as to bring the two halves of the pelvis together. In cases in which there was upward dislocation of one hindquarter, previous skeletal traction on the lower extremity was applied until the displacement had been reduced, before applying the pelvic sling.

In the series of cases described, there were three deaths. Of the remaining patients, seventeen were able to walk well within a period of four months, and the other two, who also had fractures of the femur, were walking within five months.

Demonstrations were given as follows:

*Bone Grafting of the Carpal Scaphoid* and *The Treatment of Compound Fractures of the Leg by the Use of Transfixion Pins Fixed to a Thomas Leg Splint* by Mr. J. K. McKee, Norwich.

Clinical demonstration at the Wingfield-Morris Orthopaedic Hospital: *Reduction of Congenital Dislocation of the Hip upon an Abduction Frame* by Mr. J. C. Scott, Oxford.

During the Meeting, a statement was made by Mr. W. Rowley Bristow, Hon. Orthopaedic Consultant to His Majesty's Forces at Home. He said that it was in the interest both of the nation and of the individual soldier that the very best treatment be available. More orthopaedic surgeons are required, and he trusts that surgeons of experience will give the matter their serious consideration.

# Current Literature

THE 1941 YEAR BOOK OF INDUSTRIAL AND ORTHOPEDIC SURGERY. Edited by Charles F. Painter, M.D. Chicago, The Year Book Publishers, Inc., 1941. $3.00.

In the introduction to this volume of the Year Book, the Editor has given an excellent résumé of the development of orthopaedic surgery from the "strap and buckle" stage in the preoperative period, through its escape and migration into the operative status which now equals or rivals that of any of the departments of surgery. It is a question whether it is not the operative lure, rather than the lure of the orthopaedic problem, that brings so much into its net. Too fine distinctions are not desirable, for they provoke division in the specialty itself. It is a question whether it is wise to make a discrimination between orthopaedic and industrial surgery,—the two branches which have so much in common and which are steadily merging. The Editor has wisely treated the conditions resulting from industrial trauma without distinction from those occurring in non-industrial life, and in his discussion of industrial surgery he deals with these conditions with relation to the question of litigation in those cases in which it is a factor. Emphasis is given to the need of pre-employment examination, which has not yet been accorded the position to which it is so evidently entitled.

In presenting the material which has been contributed during this past year, the articles have been put into two groups: Orthopaedic Surgery, and Industrial Surgery and Medicine. In recording the progress and the important contributions in Orthopaedic Surgery during the past year, the Editor has divided the material into thirteen groups, and the discussion of Industrial Surgery is put under five general headings. These divisions facilitate the finding of any special subject on which the reader desires to inform himself.

There are numerous reproductions of illustrations from the original articles, which supplement the text and add to the attractiveness of the volume.

The Editor wisely states that an attempt to record all of the advances which the year of study and investigation has brought forward would not only exceed the limit of the work, but would commit the error of seeming to give authority to undertake procedures which have as yet not passed the test of the end result. This adds value to that which the Editor has chosen, for it gives his endorsement to the subjects which he has selected for this volume.

The Editor quotes from articles and gives his concise and analytical survey of the essentials, and by the grouping of important articles on allied subjects he presents to the reader the present status of the knowledge on each subject in concise form, so that it may serve as a guide to the further study of any special subject.

ARTIFICIAL LIMBS AND THEIR RELATION TO AMPUTATIONS. Ministry of Pensions. London, H. M. Stationery Office, 1939. 3 shillings.

This book has been compiled by the Minister of Pensions from an unusually wide experience in the handling of the great number of amputations resulting from the War. Because the experience was so large and many of the problems were so novel, this department has been a kind of pioneer in the surgery of amputations and in the problem of providing artificial limbs. As a result, a large number of the profession have applied to the Ministry of Pensions for information, both in reference to the surgery of amputation and for advice in regard to artificial limbs. Lectures and demonstrations have been given at the Limb-Fitting Centres, and, because of the requests that they be made more widely available, this handbook has been compiled on the basis of the lecture notes.

Consideration is given, not only to the construction and fitting of the artificial limbs, but also to the more important surgical problems of providing the most practical stumps

at the different levels of the limbs for the best use of prostheses. Methods to be avoided, as well as those to be given preference, are fully discussed; and the definite instructions given will certainly help to solve the whole difficult problem.

The general construction of prostheses and the different mechanical principles of the joints have been fully discussed, as well as the control of movement by the patient and his education in the use of the limb.

The cineplastic amputations are given but a brief discussion, mainly of their history, which is quite sufficient for such a presentation of the subject.

This little book has appeared at a most opportune time and will be of help in many of the problems which will arise in military surgery.

SURGICAL PRACTICE OF THE LAHEY CLINIC, BOSTON, MASSACHUSETTS. Philadelphia, W. B. Saunders Company, 1941. $10.00.

This book of 897 pages, with 583 illustrations on 376 figures, gives the surgical practice of the Lahey Clinic. Although the many chapters which comprise the book have appeared previously as publications in various journals, taken as a whole, they present a cross section of surgery as practiced at the Clinic in recent years. Each method and technique described is one which in actual experience has proved successful in the hands of one of the members of the Clinic. All procedures have been standardized, with the result that various surgeons may perform each operation in the same way. It is felt that by choosing the procedure which seems best, by constant repetition of it, and by thorough familiarity with it, mortality and morbidity are decreased and end results are improved.

Each chapter of the book covers a region of the body. It opens with a discussion of the region and the conditions to be considered, followed by a comprehensive description of the appropriate operation. The chapter closes with a summary or concluding note, followed by a bibliography. Although all regions are adequately covered, the chapters on the thyroid, abdominal surgery, and anaesthesia are of especial interest. This book, which contains a description of the procedures which have proved their worth at the Lahey Clinic, will prove of value either for quick reference or more prolonged study.

A PRIMER ON THE PREVENTION OF DEFORMITY IN CHILDHOOD. Richard Beverly Raney, B.A., M.D., and Alfred Rives Shands, Jr., B.A., M.D. Elyria, Ohio, National Society for Crippled Children of the United States of America, 1941. $1.00.

This little book, with numerous illustrations, was written primarily to give a picture of the vastness of the problem of crippling to those not trained in medicine, and secondarily, as an elementary text for those not specially trained in the treatment of crippling deformities. The book is well written in simple non-technical terms. The abundant drawings of the usual deformities and of the methods for their correction are well chosen. The book is divided into divisions to correspond to the various parts of the body.

A book of this type is particularly timely. There has long been a want for this information in simple form. This has been stimulated by the increased interest in physical fitness, and in the prevention of crippling. Dr. Raney and Dr. Shands are to be congratulated in presenting this subject so completely. The book should be of especial value to nurses, physiotherapists, and social workers who assist in the care of children with various crippling deformities.

THE MARCH OF MEDICINE. New York Academy of Medicine Lectures to the Laity, 1941. New York, Columbia University Press, 1941. $2.00.

Under the title of "The March of Medicine", the New York Academy of Medicine has published the sixth of the series of lectures to the laity given by members of the profession. There is an introduction by Dr. Haven Emerson. These lectures are of very

distinct value in educating the public in the broader principles of medicine and surgery, and tend to bring about a mutual understanding between medical and non-medical groups. The most desirable relation of the lay public to the profession is developed on the basis of a knowledge of the capacity, as well as of the failure, to deal with disease and the control of health. The lectures have wisely avoided the clinical and pathological discussion which so often leads to anxiety and doubt because of limited knowledge, but have emphasized the advances which have added to the security and the health of the community. The importance of the constant recognition of the human side of medicine is evident in these talks, and the choice of subjects shows the effort to instruct the public along general lines, rather than to elaborate on special medical information on the subjects which are selected for these lectures.

The series consists of lectures on "Humanism and Science", "Paracelsus in the Light of Four Hundred Years", "Psychiatry and the Normal Life", "Philosophy as Therapy", "The Promise of Endocrinology", and "What We Do Know About Cancer". Each deals with a matter of special human interest. Although intended for the laity, there is much which will interest and instruct the members of the profession. It is fitting that one of the lecturers selected as his subject Paracelsus, whose influence in developing the rôle of humanism in medicine is recognized.

DIE GOLDBEHANDLUNG DER CHRONISCHEN ARTHRITIS UNTER BESONDERER BERÜCKSICHTIGUNG DER KOMPLIKATIONEN (Gold Therapy in Chronic Arthritis with Particular Reference to Complications). Fredrik Sundelin. Lund, Sweden, Håkan Ohlssons Boktryckeri (*Acta Medica Scandinavica*, Supplementum, CXVII), 1941.

Gold therapy for rheumatoid arthritis has been attracting increasing attention in America during the past five years, and, although this form of treatment has proved distinctly dangerous, a number of outstanding rheumatologists have stated that the results obtainable justify the risks. Gold, therefore, doubtlessly will receive wide clinical trial in this country during the coming years, and Sundelin's splendid monograph certainly will prove of great value to physicians using this form of treatment.

The volume, as its title suggests, deals largely with the toxic complications of gold therapy. It comprises two large sections, the first of which outlines the history of aurotherapy and reviews in considerable detail the literature relating to the toxicity of gold. The second section relates the author's experiences with the untoward effects of this treatment. His observations are based on a careful study of 1095 courses of gold therapy in 730 patients with various forms of chronic arthritis. The work is documented with 814 references and represents the most extensive analysis of the subject ever written. It is a storehouse of information.

Landé and Pick are credited with the first reports on the value of gold in treatment of chronic rheumatism rather than Forestier, who generally receives this honor in American papers.

The records reveal that the incidence of toxic reaction has been less with small doses of gold; on the other hand, serious reactions have occurred even when the doses were minute. In some instances, however, reactions were not observed when the patients were given as much as thirty grams of a gold salt, nearly ten times the usual amount administered at present. It is stated that the therapeutic effectiveness of gold is not dependent upon its bactericidal effect, but appears to rest on some subtle influence exerted on humoral resistance.

Sundelin's summary of the therapeutic claims previously advanced regarding gold therapy in arthritis indicates the basically unsound character of these reports. Lack of uniformity in designating the diseases studied, lack of controls, lack of critical judgment, and a wide variance of claims have distinguished this chapter in the literature of rheumatism therapy,—the same faults which have dogged so many previous episodes. The detailed analysis of previously reported reactions to gold therapy is critical, exhaustive, and interesting.

Introducing the second section, relating to his personal experiences with gold, Sund-

elin noted that he had included not only cases of rheumatoid arthritis, but also cases of specific arthritis, rheumatic fever, posttraumatic and chronic arthritis, spondylitis, arthritis with psoriasis and scleroderma, and even two cases of gout. Unfortunately, however, the relevant material on toxicity is not considered in relation to these various diagnoses.

The author's experiences again emphasize the danger of gold therapy. Of the 730 patients treated, six died, a mortality rate of approximately 0.8 per cent.; this figure is large. No instances of serious renal or hepatic damage were encountered, although both these toxic reactions had been reported previously with notable frequency. Eosinophilia, previously designated as a warning sign of impending toxic reactions, was found to be useless for this purpose. In most instances, eosinophilia did not appear until the toxic reaction was full blown. Complications involving the nervous system were more numerous than in previous series, amounting to 11 per cent. of all reactions noted. Two of the reactions involving the nervous system proved fatal; reports of necropsy on the brains are included.

The book contains many useful tables in which the author has summarized much important material. The work deserves high praise and represents a noteworthy addition to the literature on therapy of chronic arthritis.—*Edward F. Rosenberg, M.D., Chicago, Illinois.*

Results of Röntgen Treatment of Spondylosis Rhizomelica (Spondylarthritis Ankylopoetica). J. van Ebbenhorst Tengbergen and H. J. N. Dekhers. *Acta Radiologica*, XXII, 522, 1941.

The authors note that most of those who have undertaken roentgen therapy for spondylosis rhizomelica have observed favorable results. Twenty-seven patients were treated by means of the roentgen ray. The whole spine was arbitrarily divided into four regions from the medulla to the pelvis. As well as can be judged, the technique consisted in exposing each involved segment to 200 roentgen units, given at 180 kilovolts through eighth-tenths copper filter. The next area was exposed after a two-day interval. After rest periods of fourteen days, a second and third series of exposures were given; these apparently constituted a course of treatment. If indicated, and after an interval of six weeks, a second course and later a third course might be given. If necessary, the involved large joints were separately irradiated.

In estimating their results, the authors divided their patients into four groups:

In the first group of nine patients, symptoms had existed for less than one year. Seven were considerably improved and were able to continue with their usual daily work.

In the second group of five patients, the disease had existed less than two years, but more than one year. Only two patients obtained relief of pain and in only one was the function of the spine improved.

In the third group of two patients, the disease had existed from three to five years.

In the fourth group of eleven patients, the disease had existed over five years. Of eight patients followed, seven were relieved of pain and five were able to continue at work, but none showed any improvement in spine function.

The authors conclude, "from these 27 patients, 16 showed an evident, and two a moderate, subjective improvement; 15 were able to continue their daily work. Only in 4 patients the function of the spinal column improved. The sedimentation rate sank in 18 cases. . . . The results of roentgen treatment are favorable . . . but for all that, this form of treatment does not justify giving way to excessive optimism."—*Henry Milch, M.D., New York, N. Y.*

Complete Roentgen Ray Studies of Gastro-Intestinal Tract in 400 Arthritics. E. W. Spackman, Theodore F. Bach, C. Wesler Scull, and Ralph Pemberton. *American Journal of Medical Sciences*, CCII, 68, 1941.

The authors first investigated the gastro-intestinal tract of 100 normal patients, and set up standards of normality for determining the positions of the gastro-intestinal tract.

They divided the 100 controls into three general body builds, sthenic, asthenic, and normal. The positions of the various portions of the gastro-intestinal tract in the three different body builds were then set up. To illustrate, the position of the lower pole of the stomach in the asthenic was placed at four centimeters below the iliac crest, in the sthenic at the third lumbar vertebra, and in the normal body build at the fifth lumbar vertebra. In similar fashion they postulated the position of the caecum, hepatic flexure, splenic flexure, and sigmoid.

The authors then reviewed 400 roentgenograms of patients with all types and stages of arthritis, with regard to abnormalities in position, structure, and function of the various parts of the gastro-intestinal tract. They found that abnormalities appeared in 60 per cent. of the cases in the gall bladder, stomach, or small intestine. In 80 per cent., there were abnormalities of the colon. Hypotonicity of the colon was present in 40 per cent., and complete atonicity was present in 10 per cent. The authors could not differentiate the atrophic rheumatoid and the hypertrophic osteo-arthritic types by the roentgenographic findings of the gastro-intestinal tract in 100 cases. They admit that there are no destructive aspects of the several features studied characteristic *per se* of arthritis,—for example, pyloric irritability and duodenal spasticity, when present, appear in arthritis precisely as they do when present in cases of gastric or duodenal ulcer, or gall-bladder disease. They state that in the absence of obvious precipitating factors, such as focal infection, it is proper to give greater emphasis to the gastro-intestinal findings. Correction of the gastro-intestinal dysfunction alone cannot be expected to produce good results, unless conducted in conformity with a balanced plan of treatment including systemic rest, equilibrium of the nervous system, optimal nutrition, and the control of infections.—*Victor Wolkins, M.D., Iowa City, Iowa.*

CLINICAL INVESTIGATIONS WITH CURARE IN ORGANIC NEUROLOGIC DISORDERS. A. E. Bennett. *American Journal of Medical Sciences*, CCII, 102, 1941.

The author briefly describes the physiological action of curare, and then cites personal experiences with the clinical application of the drug.

He treated twelve cases of cerebral spastic paralysis with injections of ten milligrams of curare per twenty pounds of body weight every other day for a period of three to eight months. Orthopaedic procedures and physiotherapy were carried out at the same time. He concludes that curare produces a definite, but transient relaxing effect upon spasticity without fixed deformity. It reduces incoordination, athetosis, and dysarthria. Favorable progress occurred in the majority of patients while under curare therapy. The treatment is not dangerous, and there are no toxic reactions. Five cases of spastic paraplegia in adults, caused by transverse myelitis and advanced multiple sclerosis, were treated with curare with temporary relaxation of the spastic contractures. The effect is transient, but relief from painful spasm is afforded. The time interval during which relief is experienced is not mentioned. One case of status epilepticus, secondary to a toxic encephalitis, which had failed to respond to various sedative and other anaesthetics over a ten-day period, was treated with curare. The child had had seizures every few minutes. When seen, the child was moribund; but during twelve hours of treatment before death he was completely relaxed.

Six patients with encephalitic, parkinsonism, oculogyric crises, and paralysis agitans were relieved of their tremor and rigidity for one hour, but were unable to carry out active movements.

Four patients with Huntington's chorea were relieved of their incoordinate movements for a few hours. The author states that this is the only drug that has had any effect on the involuntary movements in this disease.

Temporary relaxation lasting one hour occurred in a number of cases of athetosis and dystonia. Temporary results were likewise seen in two cases of tetanus.

The author concludes by stating that although the action of curare is transient, continued experimentation should produce a sustained action. He briefly mentions a syn-

thetic drug, quinine methochloride, which has a curare-like action effective orally. Curare acts at the motor end plate and inhibits the action of acetylcholine on voluntary muscles.—*Victor Wolkin, M.D., Iowa City, Iowa.*

VERTEBRA PLANA (CALVÉ). Report of Two Cases. F. Y. Kuhlman. *The American Journal of Roentgenology and Radium Therapy,* XLVI, 203, 1941.

The author briefly summarizes the literature. There were twenty-seven cases reported up to 1938, seventeen being typical of the disease as originally described by Calvé in 1925. Four additional case reports have appeared since. The author describes the typical characteristics of the disease, and presents two cases. He feels the roentgenographic findings are due to aseptic necrosis of the vertebral body, and points out the frequency with which tuberculosis of the spine is confused with this disease entity.

Of interest in the two cases presented is the presence of a history of a slight antecedent trauma and of preceding acute infectious disease. In one case there was no evidence of restitution of normal vertebral contours after eighteen months.—*S. M. Albert, M.D., Iowa City, Iowa.*

MUSCLE BEHAVIOR FOLLOWING INFANTILE PARALYSIS. Herbert E. Hipps. *The American Journal of Surgery,* LIII, 314, 1941.

The author reports a study of a series of cases of infantile paralysis in which he attempted to determine whether or not a paralyzed muscle tries to recover when placed at rest in a relaxed position. He did not use transplanted muscles in the study or muscles which were hard to demonstrate,—such as the quadratus lumborum. The only patients used were those receiving physiotherapy and brace treatment, or rest and braces. The grading system used was as follows: zero, trace, poor, fair, good, normal.

The results in the three age groups studied were:

(1) Six months to six years—37.3 per cent. improvement;

(2) Six years to fifteen years—44.7 per cent. improvement;

(3) Sixteen years and over—27.3 per cent. improvement.

Two hundred and eighty-seven muscles, graded poor plus, fair, or good, showed much improvement in 87 per cent. of the cases; 276 muscles graded zero, trace, or poor showed slight or no improvement in 90 per cent.

Thus he concludes that muscles which have been paralyzed a long time, and grade only zero to trace or poor, will not benefit by prolonged rest or physiotherapy, while those which grade poor plus, fair, or good can be expected to improve with physiotherapy.

He makes the unanalyzed statement that twenty-five miscellaneous patients who received adequate treatment made an average improvement of 47.5 per cent.; twenty-one patients who received inadequate treatment made an average improvement of 20.6 per cent.

Twenty-three cases were studied to determine the relative efficiency of early treatment, beginning immediately after the temperature subsided, with the following results:

(1) Early complete rest with splinting—23.8 per cent.

(2) Early physiotherapy—68.5 per cent.

(3) No treatment (small number of patients)—31.1 per cent.—*T. J. Greteman, M.D., Iowa City, Iowa.*

END RESULTS OF SYNOVECTOMY OF THE KNEE JOINT. Ralph K. Ghormley and David M. Cameron. *The American Journal of Surgery,* LIII, 455, 1941.

The authors review Swett's original paper in which were stated the three theoretical considerations on which to base operation for this condition.

1. With foci removed, the inflammatory process in the joints subsiding, and the usual means of absorption of the inflammatory exudate having failed, manual removal of the exudate might promote the resumption of joint function.

2. Such operations might be helpful, not alone by the mechanical improvement, but by removal of organisms capable of continuing the process.

3. Stimulation of metabolism, by promp trestoration of function in atrophic disused joints and muscles, might occur.

The authors state that synovectomy may be employed in a joint in which extensive induration and fibrosis of the capsule, enlargement of the synovial villi, and persistent increase of joint fluid are present. The causes of such conditions may be as follows: chronic atrophic arthritis, traumatic arthritis, benign tumors, osteochondromatosis, syphilitic arthritis, intermittent hydrarthrosis, synovitis ossificans, hypertrophic arthritis, synovial tuberculosis, synovitis caused by a foreign body.

Their results indicate that synovectomy is most useful in traumatic arthritis, synovial osteochondromatosis, and xanthoma or benign tumors. It is of less value, although indicated, in some cases of chronic infectious arthritis. It is of value in chronic synovitis, but the prognosis should be guarded; this holds true also in intermittent hydrarthrosis.—*T. J. Greteman, M.D., Iowa City, Iowa.*

Compression of Cancellous Bone; Principal Manifestations in Head and Neck of Femur; Treatment by Connecting Drill Channels. Eugene J. Bozsan. *The American Journal of Surgery*, LIII, 537, 1941.

This is a seventy-eight-page supplement to the September issue of The American Journal of Surgery, describing the principal manifestations of compression of cancellous bone in the head and neck of the femur. The earlier pages are devoted to a review of the conceptions of hip disease during the eighteenth and nineteenth centuries.

The reason for this article is given in the author's own words. He believes, "all these conditions [osteochondritis dissecans of capital epiphysis, several forms of coxa vara, Perthes' disease, slipping epiphysis, the deforming process in congenital hip, and also the changes in the bones nearby, such as acetabulum, ischium, pubis, etc.] with some others occurring in different parts of the body, and at present not thought related, are based on one single pathogenetic element, and he shall endeavor to evolve a concept of the same which, if given the key position it merits, shall clear the prevailing confusion and shall facilitate the understanding of the grosser features of the whole group."

The author feels he has an explanation for the underlying cause of aseptic necrosis, and a clarification of the relationship of the numerous clinical manifestations. The characteristic wedge-shaped areas of aseptic necrosis may be produced by a mechanism other than infarction,—namely, by compression of a spherically shaped portion of cancellous bone.

Experimentally he has proved the following points:

1. If subjected to compression, a spherically shaped body will suffer damage in an area that is wedge shaped on cross section.

2. In three-dimensional actuality, this area corresponds to a cane with its base at the site of the application of the force.

3. The compression does not damage the whole substance of the cane, but is most effective on the jacket of it.

4. Within the compression pattern, secondary component wedges are demonstrable.

5. Each impact produces its own wedge.

6. The wedge itself is produced by bisecting compression planes inside of which the substance may be damaged.

7. Changes in the curvature of the surface and the speed of force alter the shape of the compression pattern; and, if the change occurs during the insult, a combination of patterns result, and patterns may be superimposed one upon another.

He applies this mechanistic theory to a number of conditions in the head and neck of the femur, which he feels, are all due to areas of trauma to cancellous bone, varying only in location. The same trauma also causes at times subchondral compression of the acetabular bone, resulting in osteochondritis or Perthes' disease.

The relationship of this theory of pathogenesis to causes in arthritis are also dis-

cussed. The author says he has made observations which have convinced him that compression of cancellous bone is the underlying pathological process in this condition.

There are a number of case reports. The article presents an interesting new conception of a single process in the development of many entities.—*T. J. Greteman, M.D., Iowa City, Iowa.*

NEUMOFASCIA DE LA RODILLA (Air Roentgenography of the Knee). Angel Matute V. y Jesus Salas. *Analecta Médica*, I, 9, 1940.

At present lesions of the menisci, cruciate ligaments, suprapatellar pouch, synovial membrane, and fat pads of the knee can be diagnosed only by clinical impressions. The authors have carried out contrast air studies of the knee in over 100 cases.

After nembutal sedation, the needle is inserted into the knee joint along the interarticular line, and 100 to 300 cubic centimeters of air is injected, care being taken that the needle is not in a blood vessel or that subcutaneous emphysema does not occur. The patient should be kept in bed for twenty-four hours. This technique is contra-indicated with acute infectious or traumatic conditions of the knee.

The following conditions have been demonstrated:

1. Traumatic lesions,—displaced menisci, avulsions of the tendinous fibers with chips of bone, and lesions of the intra-articular ligaments;

2. Arthritic affections,—the separation and destruction of articular cartilages in acute lesions; and ulcerations of the articular ends, loss of joint space, ankyloses, subluxations, osteoporosis, and thickening of periarticular structures in chronic arthritides;

3. Arthroses,—non-infectious articular processes, such as deposition of urate crystals, alkaptonuria, and certain endocrinopathies;

4. Arthromata,—solitary articular chondromata, non-opaque foreign bodies, and malignant soft-tissue tumors;

5. Ankylosis,—the degree and extent of fibrous ankylosis.

The authors feel that the use of the procedure is well warranted in the diagnosis of soft-tissue affections of the knee.—*Victor Richards, M.D., San Francisco, California.*

SEUDOARTROSIS DEL ESCAFOIDES CARPIANO, TRATAMIENTO POR INJERTO ÓSEO (Non-Union of Fractures of the Carpal Scaphoid, Treatment by Means of a Bone Graft). Oscar R. Maróttoli. *Anales de Cirugía*, VII, 31, 1941.

This is a very good presentation of the subject of fractures of the carpal scaphoid in which the literature is reviewed to some extent, and all aspects of the subject are covered. The author believes this fracture is considerably more common than is generally thought, and he feels it is quite frequently overlooked. The peculiar circulation of this bone is described, and to it is attributed the frequent non-union of these fractures. Most of these fractures will heal if immobilized for a sufficiently long time in the proper position, but not all of them will heal. Linear cracks do not seem to be as painful as irregular fractures. Five methods have been used for ununited fractures of the scaphoid: prolonged immobilization, blind drilling, open drilling and curettage of the fracture, bone-grafting, and excision of a fragment or all of the scaphoid. The author discusses each method. A case of his own is presented, an ununited fracture of seven years' duration, in which a bone graft, according to the technique familiar to American orthopaedic surgeons, was used. One interesting minor point is that the hand was draped by placing a sterile rubber glove on it. The author's case was followed for two years, and the patient had an excellent anatomical and functional result.—*Louis W. Breck, M.D., El Paso, Texas.*

CONSIDERACÍONES SOBRE EL TRATAMIENTO DE LAS LESIONES DEL APARATO EXTENSOR DE LA RODILLA, BASADA SOBRE HECHOS CLÍNICOS (The Treatment of Lesions of the Extensor Apparatus of the Knee, Clinical Cases). Tadeo Sokolowsky. *Anales de Cirugía*, VII, 63, 1941.

This article is a discussion of the subject of fracture of the patella and rupture of the quadriceps tendon of the knee. The subject is covered as to anatomy, pathology, symp-

toms, and treatment, and is a thorough discussion of the subject. In simple fractures of the patella with separation of the fragments, the author does a careful repair of the tendinous tissue overlying the patella, paying less attention to the knee-cap itself, and being especially careful to repair the aponeurosis on each side of the patella. Only in badly comminuted and in compound comminuted fractures, does he completely remove the patella. Complete rupture of the quadriceps or patellar tendon requires immediate surgical repair. The author lays great stress on early motion in all types of cases, and feels it is of the utmost importance in order to prevent stiffness. He uses a Braun splint for support when motion is begun. For the short time the cast is used, he employs a short light one with the knee in slight flexion, and uses this type of cast even in those cases of fracture without displacement, which were treated non-operatively. Seven cases illustrating various types of lesions are presented.—*Louis W. Breck, M.D., El Paso, Texas.*

RADIOLOGICAL APPEARANCES OF OSTEOARTICULAR LESIONS IN LEPROSY STUDIED THROUGH RADIOLOGY. Mario Soares Da Veiga. *The Antiseptic*, XXXVIII, 579, 1941.

From the X-Ray Institute of Portuguese India, Da Veiga presents an interesting radiological study of the osteo-articular lesions of the hands and feet of 100 lepers. These lesions, which were found in 98 per cent. of the cases examined, are essentially of a destructive character, taking the form of osteoporosis or of osteitis. They are observed generally in patients with cutaneous involvement and with slight changes in the nervous system, and are regarded by the author as a result of local infection through vascular channels. Osteo-articular changes in leprosy of the neurodystrophic type are the result of leprous involvement of the nervous system, and are revealed under the forms of bone destruction, diffuse osteoporosis, and mutilations, often with symmetrical localization.—*Robert M. Green, Boston, Massachusetts.*

ARTRODESE A DELAHAYE NA CURA DA TUBERCULOSE DO JOELHO (Delahaye's Arthrodesis in the Treatment of Tuberculosis of the Knee Joint). Barros Lima. *Arquivos Brasileiros de Cirurgia e Ortopedia*, IX, 75, 1941.

The Delahaye operation is an extra-articular fusion of the knee joint accomplished by a long, flexible, curved, tibial graft, inserted into the anterior surface of the femur, patella, and tibia.

The author has used this method and found that, in spite of a few disadvantages, the method is very useful and should be considered valuable in the treatment of tuberculosis of the knee joint in infants. In view of the danger of growth impairment in intra-articular fusion in children and of other difficulties, the method of Delahaye is preferable. Four cases are presented by the author.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

FRATURAS DA COLUNA DORSO-LOMBAR (Fractures of the Thoracolumbar Spine). Bruno Maia. *Boletim do Instituto de Assistencia Hospitalar*, II, 44, 1941.

The article is based on the experiences of the First-Aid Service of Pernambuco. An analysis and literary review of the subject is presented. The author gives abstracts of eighteen cases of spine fracture, and comes to the following conclusions:

Fractures of the thoracolumbar spine are more frequent than fractures in other regions of the spine.

Roentgenography is the best method of diagnosis.

The most constant subjective symptom is pain in the area of fracture.

The majority of fractures do not show involvement of the nervous system.

Anaesthetic infiltration by the Leriche method in fractures of the spinous and transverse processes, is indicated.

In the treatment of fractures of the bodies of the thoracolumbar vertebrae, the method of Watson-Jones under local anaesthesia, as modified by Böhler, is preferable.

The Watson-Jones reduction of these fractures, with the modification of Kortnetz (hyperextension on a canvas frame), is preferable to the method of Schotte-Zeno (suspension in thoracic hyperextension).

The functional results obtained by the method of Watson-Jones and Böhler are satisfactory.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

HALLUX VALGUS. SURVEY OF END RESULTS OF VARIOUS OPERATIVE PROCEDURES FOR CORRECTION OF HALLUX VALGUS PERFORMED AT THE HOSPITAL DURING THE PAST TEN YEARS (1931–1940). Louis S. Nelson and Emanuel Kaplan. *Bulletin of the Hospital for Joint Diseases*, III, 17, 1942.

For a study of the comparative value of the operative treatment of hallux valgus, seventy-nine patients, who had been operated upon one to ten years before, were reexamined. On these seventy-nine patients, with thirteen unilateral and sixty-six bilateral conditions, 145 operations were performed. These included particularly the procedures described by Silver, Kleinberg, Kellar, Stein, Lapidus, McBride, Peterson, and Levine. The average period of hospitalization was lowest after the Peterson, Silver, and Kellar operations. On an average of three to three and one-half weeks after the Kellar and Silver operations, weight-bearing was possible, but the patient returned to activity more quickly after the Kellar, than after any of the other operations. The percentage of patients satisfied with the postoperative result was greater after the Silver operation than after any other.

The authors feel justified in recommending the Silver operation in mild cases, in patients under twenty years of age. In severe cases the Kellar operation is considered most effective. In patients from twenty to forty years of age, the Stein and McBride operations were effective. In severe cases, the Kleinberg and Lapidus procedures proved satisfactory, although the convalescent period was long. The Kellar operation was recommended, irrespective of age or severity of lesion. In mild cases in patients over forty, provided there was no arthritis, the Silver operation and exostectomy gave good results. In the presence of arthritis, these operations are inadvisable. The Kellar operation appeared to be the operation of choice in the presence of severe deformity and arthritis.—*Henry Milch, M.D., New York, N. Y.*

FRESH COMPOUND FRACTURES. TREATMENT BY SULFONAMIDES AND BY INTERNAL FIXATION IN SELECTED CASES. Willis C. Campbell and Hugh Smith. *The Journal of the American Medical Association*, CXVII, 672, 1941.

The authors' report is based on three years of experience in this method of treatment, and includes a series of fifty private patients treated under optimum surgical conditions, with adequate postoperative care and follow-up, and ninety-three patients of the municipal hospital treated under less favorable conditions. Sulfonamides were used in the entire series; metallic, internal fixation in forty-two of the cases; and primary closure of wounds in the majority. No set routine was followed for all compound fractures, but in general the treatment consisted in adequate débridement, copious irrigation with normal saline, and implantation of five to twenty grams of sulfanilamide crystals in the wound, metallic fixation when indicated—using vitallium stainless steel—followed by primary closure in all cases except those of more than twelve hours' duration, those with soft tissues so extensively mangled that closure of the skin was impossible, or those in which complete débridement was impossible, as in shot-gun wounds of a fleshy part.

In comparing this entire group with a group of seventy-five compound fractures in which neither internal fixation nor the sulfonamides were used, it was found that the percentage of union and non-union, and the average time required for union in the two groups, was approximately the same.

Primary closure, in conjunction with sulfonamide therapy, did not increase the incidence of gas gangrene, nor was there a sufficiently striking decrease in its incidence to in-

dicate a particularly beneficial effect of the sulfonamides on the gas-producing organism. The incidence of infection was reduced from 33.3 to 18.1 per cent.; only two of 143 patients who received sulfonamide died from infection, as compared with three in the control series.

In a comparison of the forty patients in whom internal fixation was used, with the fifty-two in whom no internal fixation was used, it was found that there were fourteen infections and eleven non-unions in the former group, and eleven infections with three non-unions in the latter. There was little difference in the average period required for union between those with and those without internal fixation. The high incidence of infection and non-union in the group with internal fixation, is partially explained by the fact that it was used in those with severe fractures in whom a higher percentage of infection and non-union could be expected. The authors feel that their results have been materially improved by these measures, and do not hesitate to use internal fixation when indicated.—*Brandon Carrell, M.D., Dallas, Texas.*

Concealed Ruptured Intervertebral Disks. A Plea for the Elimination of Contrast Mediums in Diagnosis. Walter E. Dandy. *The Journal of the American Medical Association*, CXVII, 821, 1941.

The author makes a plea for elimination of contrast media for localization of ruptured vertebral discs, and presents observations on concealed types of ruptured intervertebral discs which cannot be diagnosed by intraspinous injections.

He avoids spinal injections because they are not necessary; they add to the patient's discomfort; they may mislead; the permanent deposit of iodized oil in the brain and spinal cord is thereby avoided. Diagnosis is based on low mid-line lumbar backache, plus recurring, but not continuous pain down the back of one or both legs, intensified by coughing or sneezing. There may or may not be diminution of the Achilles reflex, or sensory or motor loss in the distribution of the fourth and fifth lumbar, or first sacral nerve. History of trauma may be difficult to elicit, and need not be obtained for diagnosis.

A concealed disc explains many negative explorations. The author has had a series of eight in one month. They were diagnosed only at operation, by careful inspection beneath the dura. The disc, which was softer than normal, was found bound to the emerging spinal nerve by adhesions; and often when the forceps were withdrawn, soft brownish material clung to the instrument. The chances of finding a concealed disc is a further reason for abandoning the procedure of contrast media.—*Clyde B. Trees, M.D., Dallas, Texas.*

Roentgen Therapy for Rheumatoid Arthritis of the Spine (Marie-Strümpell Arthritis; Spondylitis Rhizomélique). C. J. Smyth, R. H. Freyberg, and Isadore Lampe. *The Journal of the American Medical Association*, CXVII, 826, 1941.

The authors report the result of roentgen therapy in a series of fifty-two cases of rheumatoid arthritis. Seventy-two per cent. of the patients were benefited subjectively, and 26 per cent. objectively. In some of the cases improvement was on a psychogenic basis. Other patients, however, showed no improvement until the radiation treatment actually was given.

Thirty-two of the patients were checked in regard to sedimentation rate. Forty-one per cent. of this series showed improvement of three-tenths millimeters per minute, or more, in sedimentation rate. In all except one of these, there was clinical improvement. In 9 per cent. an increase in sedimentation rate occurred.

Seventeen patients examined by roentgenography showed no anatomical improvement, and in eight there was actual increase in calcium deposits.

The only potentially serious effect was danger of leukopenia. This occurred only among those receiving the second course of treatment, and in one case the white cell count dropped to 1,100 cells per cubic centimeter. Recovery was complete, however, in a

month's time, and none of the patients showed serious symptoms. Gastro-intestinal symptoms (nausea and vomiting) occurred in some patients four to six hours after treatment, and subsided in two or three days.—*Clyde B. Trees, M.D., Dallas, Texas.*

FRACTURES OF THE SPINE. A STUDY OF TWO HUNDRED CASES. S. Bernard Wortis and Lewis I. Sharp. *The Journal of the American Medical Association,* CXVII, 1585, 1941.

In this article the authors report their study of 200 cases of fracture of the spine in order that a rational routine of treatment might be formulated.

The authors differentiate between complete transverse division of the cord and only partial injury, with the idea that only on the basis of a correct differentiation can proper treatment be instituted.

In the treatment of fractures of the spine they express conservatism and enumerate the procedures and indications which they have found most effective.

The authors suggest that one may remain rather optimistic, even with an apparent severe cord injury, except in cases with flaccid paraplegia and the presence of Gordon-Holmes slow flexion reflex, when the outlook is rather poor.—*Sidney L. Stovall, M.D., Dallas, Texas.*

INJURIES OF THE INTERNAL SEMILUNAR CARTILAGE. POSSIBLE PREDISPOSITION TOWARD; SYMPTOMS AND TREATMENT. Edward K. Cravener and Donald G. MacElroy. *The Journal of the American Medical Association,* CXVII, 1695, 1941.

Following a brief review of the anatomy and the theories concerning the function of the internal semilunar cartilage, the authors describe the different locations of the lacerations in their series. Forty-five per cent. occurred in, or passed through, the avascular portion where healing cannot take place. In only 30 per cent. was there dislocation or disarrangement of structure so as to allow locking of the knee in flexion or extension. Pain was present in 100 per cent., a feeling of instability in 90 per cent., and intermittent swelling in 85 per cent. In 45 per cent. there was pain on rotation of the leg upon the flexed femur, and in 33 per cent. tenderness exactly over the joint line.

In reviewing a large series, the authors found that the injury occurred at an average age of twenty-nine years, and more frequently in overweight, poorly muscled, or sedentary men whose pelves were broader than normal for their body height.

The authors advocate plaster fixation (following reduction when necessary) for a six weeks' period in all cases of primary injury, since 55 per cent. of the lacerations are in the vascular area and will heal. In the remaining 45 per cent., symptoms will recur, and of this group operative removal will completely cure 72.33 per cent. Failure of operative cure may be due to faulty diagnosis, failure to recognize a concomitant injury of the anterior crucial ligament, failure to remove the major portion or all of the cartilage, injury to the articular cartilage, damage to the internal lateral ligament, persistent synovitis, failure to operate within one year, and regeneration of cartilage.—*Brandon Carrell, M.D., Dallas, Texas.*

UNCOMPLICATED FRACTURES OF RIBS AND MAJOR INJURIES OF THE CHEST WALL, TREATMENT BY INFILTRATION WITH LOCAL ANESTHETIC. Paul H. Harmon, Dan R. Baker, and Robert D. Kornegay. *The Journal of the American Medical Association.* CXVIII, 30, January 3, 1942.

The authors describe a method of treating both minor fractures of the ribs and major injuries of the chest wall by local infiltration with a solution containing 0.5 per cent. procaine hydrochloride and 0.1 per cent. eucupine dihydrochloride, to which epinephrine hydrochloride (10 drops per 100 cubic centimeters) has been added. The advantages claimed for this method are: (1) Pain is immediately abolished; (2) the vital capacity

and the tidal air remain at a more normal level; (3) excessive coughing due to pleural irritation is diminished; (4) the use of general sedatives and cough mixtures is lessened; and (5) the injection is a minor procedure. The only absolute contra-indications are: (1) known hypersensitivity to procaine or epinephrine hydrochloride and sometimes sensitivity to the quinine series of drugs; and (2) a dirty or infected wound in the skin which cannot be blocked off from the field of injection.

In thirty-two cases of minor fractures, one injection was sufficient in twenty-four, two in the remaining eight. The average period of disability until the patient returned to his former work was four and two-tenths days.

This treatment was also used in five cases of severe chest injuries with marked relief of pain and improvement in general condition.—*Brandon Carrell, M.D., Dallas, Texas.*

A Method of Treatment of Burns and Wounds. John Bunyan. *The Medical Press and Circular*, CCVI, 103, 1941.

The author enumerates the requirements for the proper treatment and healing of burns and wounds, and discusses the three main reasons for failure of proper healing,—namely, chemical, physical, and bacterial irritants.

To satisfy all the requirements for healing and to eliminate the undesirable factors which delay or prevent healing, the author devised an envelope of coated silk which is drawn on over the limb or body. This envelope is transparent, flexible, frictionless, bland to the tissues, excludes secondary infection, and is fitted with two openings through which an irrigating solution may be introduced and drained out simultaneously. The solution which he uses is electrolytic sodium hypochlorite, standardized and stabilized at 1 per cent.

After mechanical or surgical cleansing, the involved area is washed with a solution of electrolytic sodium hypochlorite and dried. The sterilized envelope is applied and strapped to the body with adhesive. Daily thereafter the area is irrigated for twenty minutes by inserting the nozzle of a syringe into the opening of the envelope. The envelope is drained for thirty minutes. Oxygen is run in and the inlets are sealed. This procedure is carried out thrice daily.

The author presents some cases showing the results and the time of healing which illustrate the success of this new method.—*Herbert E. Hipps, M.D., Marlin, Texas.*

The Treatment of Compound Fractures of the Femur. R. Weeden Butler. *The Medical Press and Circular*, CCVI, 285, 1941.

First aid is best given by immediately fixing the limb in a Thomas splint with moderate traction. If no splint is available, both legs should be fastened together and tied to a long, straight slat, or bar.

At the hospital, the patient is treated for shock, the limb is x-rayed, and antitetanic and anti gas-gangrene sera are given.

The operation is done as soon as possible, with continuous drip transfusion being carried on during the operation. Free excision of damaged muscle and devitalized tissue is carried out, and foreign bodies are removed. Chemical cleansing with antiseptics is not used, but sulfonamide powder is sprinkled into the wound, and sulfonamides are continued by mouth for three or four days after the operation. Unless it is a minor one, the wound is usually packed open with vaseline gauze.

The author discusses the advantages of the plaster spica versus traction with a pin below the knee, and the different dressings used in and on the wound.

For extensive loss of skin, early skin-grafting is advisable. He warns against manipulating a stiff knee after a fractured femur, as the tightness is due to the adhesions between the quadriceps and the femur, and not to intra-articular adhesions.—*Herbert E. Hipps, M.D., Marlin, Texas.*

THE SEQUELÆ TO INJURIES OF THE BONES AND JOINTS. St. J. D. Burton. *The Medical Press and Circular*, CCV, 376, 1941.

Early undesirable sequelae following injuries may be lessened by operative treatment as soon as shock is relieved, by better immobilization, and limitation of the wound dressings.

Wounds involving the shoulder joint may leave some stiffness, but even with complete bony ankylosis there remains little disability if it occurs in the ideal position (60 degrees abduction, 30 degrees external rotation, and elbow forward).

Elbow wounds frequently result in stiffness. If ankylosis is expected, the forearm and arm should form an angle of 120 degrees. The forearm should not be fixed in complete pronation. About half way between this and complete supination is preferable, and leaves a hand which can be used in most trades.

Hand wounds are always serious. Fingers, if ankylosed, should be in slight flexion.

Hip-joint injuries are always serious. Visceral complications, extensive suppuration, and, with healing, traumatic arthritis or ankylosis usually occur.—*Herbert E. Hipps, M.D., Marlin, Texas.*

GOLD INFECTIONS IN THE TREATMENT OF ARTHRITIS. Doris M. Baker. *The Medical Press and Circular*, CCVI, 419, December 3, 1941.

Good results may be obtained with chrysotherapy if the cases are properly selected. The best results are obtained in patients with multiple involvement of an infectious or rheumatoid type of progressive arthritis. Osteo-arthritis, the arthralgias, gouty arthritis, gonorrheal arthritis, and spondylitis do not respond to this treatment.

The stage of the disease is immaterial, and age is of no importance.

Contra-indications are few, but definite. The kidneys must be functioning normally. The liver must be normal, no blood abnormality should be present, and any secondary anaemia must be corrected.

Before beginning treatment, all foci of infection should be eliminated.

The toxic symptoms are presented and discussed.—*Herbert E. Hipps, M.D., Marlin, Texas.*

FRACTURES OF THE FOREARM AND ELBOW IN CHILDREN. AN ANALYSIS OF THREE HUNDRED AND SIXTY-FOUR CONSECUTIVE CASES. Augustus Thorndike, Jr., and Charles L. Dimmler, Jr. *New England Journal of Medicine*, CCXXV, 475, 1941.

The authors present a valuable review of the methods of treating fractures of the forearm and elbow, and indicate that the incidence of such fractures in children under twelve years of age is high. They advise closed manipulative reduction; but if open reduction is necessary for alignment, it should be carried out within forty-eight hours. In their series, the incidence of open reduction was 1 per cent. in fractures of the distal forearm; none in the proximal two thirds; and 6 per cent. in fractures of the elbow. They discuss the well-accepted methods and position of fixation after reduction.

In fractures of the elbow, with the exception of those of the olecranon, the acute flexion position was used, with the position being maintained in the so-called "pistol holster" sling which permits ready inspection of fingers, hand, and radial pulse.

The authors condemn the indiscriminate use of open reduction, and the utilization of bone plates, screws, or other forms of advertised hardware, in treating fractures of the distal third of the forearm.—*S. A. Adland, M.D., Iowa City, Iowa.*

CALCAREOUS TENDINITIS (PERITENDINITIS CALCAREA) AT THE GREATER TROCHANTER OF THE FEMUR. Louis Kaplan. *Pennsylvania Medical Journal*, XLV, 37, October, 1941.

This condition occurs most commonly at the shoulder, but may occur at other points in the body, such as the supratrochanteric area of the hip, about the insertion of the

flexor carpi ulnaris into the pisiform bone at the wrist, at the ankle, the knee, the elbow, and about the metacarpals and phalanges.

The author reviews the pathology of calcareous deposits, and suggests the term "calcareous tendinitis" as a name which describes the lesion,—since the deposits are in the substance of the tendon, and not around the tendon.

Two cases of "calcareous tendinitis" at the hip are presented, one being bilateral with no symptoms on the right side. The acute symptoms appear to be due to an acute inflammatory reaction about the deposit, with an increase in the tension in the calcified area. Relief of the tension relieves the symptoms, the deposit being then absorbed.

For treatment he uses procaine infiltration of the involved area by which he obtains relief of symptoms with one or two injections of 25 cubic centimeters of 1-per-cent. procaine hydrochloride solution. These patients were seen three and six months later when there was relief of symptoms and dispersion or disappearance of the calcification.—*I. Ponseti, M.D., Iowa City, Iowa.*

TRANSPLANTATION OF FIBULA FOR NONUNION OF TIBIA: REPORT OF CASE. M. S. Henderson and W. H. Bickel. *Proceedings Staff Meetings Mayo Clinic*, XVI, 510, 1941.

The authors report a case of a compound, comminuted fracture of the left tibia and fibula in the upper third, which was treated outside of the Clinic in 1937. In 1940 the roentgenogram of the left leg revealed a non-union of an old comminuted fracture of the upper third of the tibia and fibula, with the loss of about one inch of bone, and that the head of the fibula was united by bony fusion to the superior lateral aspect of the tibia.

An osteotomy of the fibula was done, and it was swung against the tibia after the lateral surface had been freshened. It was held there by a Parham band. Five months later the leg felt solid. It was also stated that the Parham band was to be removed after there was solid union.

If there is non-union of the tibia, and the fibula is intact, there are two methods of choice: (1) an autogenous bone graft, (2) Huntington's operation.

Huntington's operation is the transplantation of the fibula to the tibia in two stages, fusing the upper end first.—*D. L. McCain, M.D., Iowa City, Iowa.*

ARTHRODESE DA TIBIO-TARSICA NA PARALYSIA INFANTIL (Tibiotarsal Arthrodesis in Infantile Paralysis). Paulo Zander. *Revista Brasileira de Orthopedia e Traumatologia*, II, 107, 1940.

In certain cases of completely flail ankle joint, a fusion of the joint results in a very satisfactory foot. The author uses a modified technique. The astragalus is removed and denuded of its cartilaginous surfaces, the cartilage is also removed from the tibia and the scaphoid. A few vertical, deep, saw cuts are made into the articular surface of the tibia and the astragalus and, if necessary, in the other small bones of the tarsus; the astragalus is replaced and the ankle is fixed in slight equinus. In the four patients operated upon, the author was impressed by the very firm fusion of the bones which occurred within a few weeks, and ventures the opinion that it may even be possible to accomplish a fusion of the ankle joint by deep cuts into the articular surfaces without removal of the cartilage of the joint.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

THREE PATIENTS SHOWING THE RESULT OF TREATMENT OF CARPAL DISLOCATION. F. A. Simmonds. *Proceedings of the Royal Society of Medicine*, XXXIV, 507 (Section of Orthopædics p. 11), 1941.

The author presents three cases of anterior dislocation of the carpus, following hyperextension injury to the wrist, all three of which failed to respond to manual reduction. Symptomatology was characterized by swollen wrist, immobile fingers, and

evidence of "median nerve irritation". The first case responded to skeletal traction by means of Kirschner wires through the metacarpal bases and the olecranon, and the use of the Zimmer apparatus. The dislocation was reduced by manipulation while the traction was active.

The other two cases failed to respond to this skeletal distraction method, and open reduction was necessary.

The author is also of the opinion that excision of the lunate alone gives a good result, but that removal of the scaphoid results invariably in a very poor wrist. He, therefore, feels that when excision of the scaphoid becomes necessary, the entire proximal carpal row should be removed. The latter procedure offers a prospect of a fair end result.—*S. M. Albert, M.D., Iowa City, Iowa.*

DA RADIOTHERAPIA NA PERI-ARTHRITE ESCAPULO-HUMERAL (X-RAY THERAPY IN SCAPULOHUMERAL PERIARTHRITIS). Achilles de Araujo e Carlos Osborne. *Revista Brasileira de Orthopedia e Traumatologia*, II, 235, 1941.

The authors report a series of fourteen cases of periarticular arthritis and bursitis in which deep roentgen-ray treatment was carried out. Direct irradiation, with 100 to 120 roentgen units given twice weekly over the affected area, was used.

After the first treatment the pain diminished considerably, and sometimes after the second or third ceased completely. The opaque shadows in the subdeltoid areas showed a tendency to decrease in size, or completely disappear. The clinical improvement was rapid and effective in thirteen cases of this series.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

UM NOVO TIPO DE PLACA PARA OSTEOSINTESE (A New Type of Plate for Bone Fixation). Octavio Caputti. *Revista Brasileira de Orthopedia e Traumatologia*, II, 274, 1941.

A new metal fixation plate is described, consisting of a horizontal plate with a vertical piece arising from the undersurface of the horizontal part, forming a sort of T. A slot is made in the proximal and distal fragments of the bones which are to be fixed, the vertical part is introduced into the slot, and the horizontal plate is fixed with screws to the cortex of the bone. In this fashion the lateral, as well as the anteroposterior, displacement of the bone is prevented.

The author believes this plate has an advantage over the Hawley plate (*The Journal of Bone and Joint Surgery*, XX, 469, April 1938)—made in the form of an L, and based, perhaps, on the same principles—because of the greater ease of its removal.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

LUXACION HACIA ADELANTE DE LA EXTREMIDAD INFERIOR DEL CUBITO. SECUELA DE FRACTURA DEL TERCIO INFERIOR DEL RADIO (Forward Dislocation of the Distal End of the Ulna Following Fractures of the Distal Third of the Radius). Herbert Cagnoli. *Revista Brasileira de Ortopedia e Traumatologia*, II, 365, 1941.

The author calls attention to the comparative frequency of the indirect forward dislocation of the distal end of the ulna, which develops slowly, following malunited fractures of the distal third of the radius. In these fractures, an anterior angulation of the radius produces a disorganization of the distal radio-ulnar joint, with a distention of the anterior ligament of this joint. The articular surface of the radius remains in contact with the carpal bones, but the ulna luxates forward. The author describes three cases of varying gravity. In an early and mild case, an osteotomy of the radius to correct the deformity was sufficient. In a more severe case a reconstruction of the anterior ligament of the distal radio-ulnar joint with a periosteal graft from the tibia was added to the osteotomy of the radius. In a very severe case, in addition to the corrective osteotomy of the angulation of the radius, the dislocated end of the ulna was completely removed.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

ANALISIS EXPERIMENTAL DE LAS SOMBRAS EN LA NEUMOARTRORRADIOGRAFIA DE LA RODILLA NORMAL (Experimental Analysis of the Shadows in the Pneumoroentgenography of the Normal Knee). Enrique H. Lagomarsino y Hector Dal Lago. *Revista de Ortopedia y Traumatología*, X, 393, 1941.

As a result of personal experience with arthroscopy and pneumoroentgenography applied to the knee joint, the authors have rejected arthroscopy because of its doubtful results and because it implies opening the joint. They believe an exploratory arthrotomy would give better results. The introduction of liquid contrast media into the joint has always produced articular reactions. Their latest practice has been to inject air into the joint until there is enough tension to give an elastic sensation, but not enough to cause a sharp pain, as pain is considered to be due to an injury of the articular structures.

Interpretations of the roentgenographic shadows of a normal knee joint differ according to the various schools of thought, with consequent different interpretations of the pathology. The authors have undertaken studies of roentgenograms of normal knee joints and have analyzed the results. They made roentgenograms of knees in which the cruciate ligaments and menisci had been resected, and found that the shadows of the articular cartilage of the femur and tibia were not of a uniform thickness of three millimeters, but were thicker at the middle portion of the femoral condyle and gradually became thinner toward the intercondylar notch. Other roentgenograms were made of knees from which a part or the whole of the cartilage had been removed, or in which the cruciate ligaments had been resected, and their shadows were compared with those on roentgenograms of normal knee joints with all the structures intact.

The article is profusely illustrated. The authors believe they have demonstrated that there is a disparity between the usual interpretation of a roentgenogram of a normal knee joint and their findings.—*Leon Avila, Jr., M.D., San Salvador, El Salvador.*

LUXACIÓN ACROMIOCLAVICULAR. DISPOSITIVO PARA SU TRATAMIENTO Y TRABAJO EXPERIMENTAL (Acromioclavicular Dislocation. A Method of Treatment and Experimental Work). Domingo Muscolo. *Revista de Ortopedia y Traumatología*, XI, 69, 1941.

Due to the disposition of the articular surfaces of the acromioclavicular joint, the clavicle has a tendency to slide over the acromion, when pressure is applied on the shoulder in a downward and medial direction. At first the ligaments stretch; then, if the force continues, they tear.

According to general opinion, the isolated rupture of the acromioclavicular ligaments produces only a certain degree of subluxation of the clavicle, and the rupture of the coracoclavicular ligaments is indispensable in producing a complete dislocation.

In order to verify these facts the author experimented on a cadaver by cutting the coracoclavicular ligaments. Roentgenograms taken while the arm was pulled strongly downward showed only a slight subluxation of the clavicle. In the opposite shoulder the capsule and the acromioclavicular ligaments were cut, the coracoclavicular ligaments being left undisturbed. This time the roentgenograms showed a complete dislocation of the clavicle.

In order to treat such a dislocation, the author applies a shoulder spica which extends down to the hips and includes the upper two thirds of the arm. A window is cut over the acromioclavicular joint, and a U-shaped iron bar is included in the cast over the shoulder. This bar holds a screw device in the middle to apply pressure over the clavicle. The pressure should be increased a little every day, so as to obtain reduction on the third day. A quick reduction is not desirable because the skin may slough. Two cases have been treated in this way with good results.—*Leon Avila, Jr., M.D., San Salvador, El Salvador.*

CIRCULACIÓN DEL EXTREMO SUPERIOR DEL FÉMUR (Circulation of the Proximal End of the Femur). Jorge Zarazaga. *Revista de Ortopedia y Traumatología*, XI, 26, 1941.

By combining roentgenographic and transparency methods, investigations were undertaken on cadavera ranging from foetuses nine months old to those of persons fifty-four years old. The author believes, as most authors do, that the proximal end of the femur gets its blood supply from three different vascular regions: the diaphysis from the femoralis profunda (first perforating), and the epiphysis from the posterior and anterior circumflex arteries, and from the artery of the round ligament.

According to his observations, the artery of the round ligament is of definite importance to the blood supply of the femoral head in 75 per cent. of the cases, anastomosing with the epiphyseal branches of the other vascular regions. In 25 per cent. of the cases it was found that this artery ends in the fovea capitis. In the nine-months foetus the artery ends in the fovea capitis, but as age advances, it penetrates the head to anastomose with the other arteries.

The posterior circumflex artery supplies blood to the largest part of the proximal end of the femur, including the head and two-thirds of the trochanteric mass, and anastomoses with the nutrient artery and that of the round ligament.

The anterior circumflex, through its subepiphyseal branch, nourishes part of the epiphyseal cartilage, and, when growth is over, supplies the blood for a seventh of the epiphysis and a third of the trochanteric mass.

The nutrient artery is a factor in the blood supply of the proximal end of the femur, anastomosing with branches of both circumflex arteries.—*Leon Avila, Jr., San Salvador, El Salvador.*

THE TREATMENT BY LOCAL INJECTIONS OF SOME FORMS OF LOW BACK PAIN, SCIATICA AND LUMBAGO. AN EDITORIAL. *Rheumatism*, II, 1940.

Injection of the correct solution into painful muscles of the low back has produced in many cases dramatic results. It was presumed that the anaesthetic solution paralyzed the motor nerve centers in the muscles, and thus caused the spasm to disappear. Recently doubts have arisen in regard to this hypothesis.

It is pointed out that in examining a painful back, acutely painful areas are found in the muscles. These localized points, when treated with heat and light massage, lose much of their tenderness to pressure. As this pain disappears, so do the symptoms from which the patients are complaining,—such as lumbago, sciatica, brachial neuritis, and other rheumatic manifestations. There are two possible explanations of this: (1) The pain was referred from nerve centers in a rheumatic nodule; (2) the spot was an ischaemic area, and when this was rendered hyperaemic by heat and massage, the pain disappeared and thus the symptoms were relieved.

In most cases of non-articular rheumatic pain, myalgic spots may be readily demonstrated. If the sciatic or lumbar pain is due to some other cause, these points of pain are not present. When present, they usually lie along the edge of the quadratus lumborum, near the upper portion of the gluteus medius, and in the deep piriformis. Occasionally the upper edge of the gluteus maximus may be affected.

Treatment is based largely upon injection of a .025-per-cent. solution of procaine into the myalgic spots. The points of tenderness are marked with an iodine swab, and then about two cubic centimeters of the solution is injected into each spot. In most cases the pain is relieved immediately, and practically normal motion at the lumbar spine results. Within a few hours the original pain may return in an aggravated form, but this usually disappears. In some cases a series of two to three injections is necessary to produce a complete cure. A successful result may be expected in those in whom the muscle spasm is the cause of the pain and the consequent disability.—*H. M. Childress, M.D., Charleston, South Carolina.*

TREATMENT OF FRACTURES OF THE LOWER THIRD OF THE HUMERUS. F. Adelbert Hoshall. *Southern Medical Journal*, XXXIV, 1152, 1941.

The narrator is convinced that skeletal traction with a shoulder spica is the method of choice in these cases. He is equally convinced that when there is a displaced fragment of either the medial or lateral condyle or epicondyle, open reduction is required, with wiring, pinning, or suturing of the displaced fragment, and holding the arm in a cast in the position of greatest immobility. Open operation was done in fifteen of 204 cases. A detailed description of the various fractures involving the condyles is included.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

FRACTURES OF THE HIP. THE PRESENT STATUS OF ITS TREATMENT. R. T. Hudson. *Southern Medical Journal*, XXXIV, 1154, 1941.

This includes both intracapsular and extracapsular fractures. Internal fixation under roentgenographic control is advocated. The author prefers to use four Moore pins for both the intracapsular and the intertrochanteric fractures. No type of external fixation is needed in the after-care.

He also recommends Murray's subtrochanteric osteotomy for cases of non-union of fracture of the hip.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

HISTORICAL REVIEW OF METALS USED IN ORTHOPEDIC SURGERY. F. Walter Carruthers. *Southern Medical Journal*, XXXIV, 1223, 1941.

This is a historical review of the metals used in the fixation of bones from Fabricius to the present day. Malgaigne in 1840 used his metal clamp for fractures of the patella. Lambotte used metal plates and screws in 1902. Rugh experimented with sixteen different types of metal. Lane in 1905 did much to popularize the use of metal plates and screws. John B. Murphy also advocated nails, screws, and wires. Many other surgeons are mentioned who have used various types of metals. Vitallium is one of the most popular and highly recommended of modern metals. The last author mentioned is Key who has recommended the stainless steel 18–8 SMO.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE USE OF SULFONAMIDES IN CLEAN OPERATIVE WOUNDS. J. Albert Key. *Southern Medical Journal*, XXXV, 55, January 1942.

In spite of the advance in operating-room technique, a certain number of clean wounds become infected in even the best hospitals. Many new methods are being studied to reduce still further the number of these infections. Key, having determined that small amounts of sulfanilamide powder placed in the wounds did not delay healing, has been using this powder routinely in all clean operative wounds for the past two and one-half years. He presents a series of 150 cases with no postoperative infections. During the past year he has been using sulfathiazole from sterile ampules. Sometimes he combines the two drugs. In no case has there been any systemic reaction to the drug. Its use should not allow any relaxation in the most rigid aseptic technique.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

SLIPPING OF THE UPPER FEMORAL EPIPHYSIS. M. Beckett Howorth. *Surgery, Gynecology and Obstetrics*, LXXIII, 723, 1941.

The author reports on forty cases, the end-result standard being a painless hip, free of limp, and with full motion and full capacity for normal activity.

In the preslipping stage, it is desirable to prevent weight-bearing, and not to apply a cast because of the atrophy of disuse. One-half inch or more of slipping should be

present before reduction is attempted. Reduction of less than one-half inch of slipping was attempted in twenty-one cases with only three successful results. Heavy traction has been tried by the author with good results.

Eleven open reductions were performed; six were osteotomies and gave only fair results. From 1930 to 1939, seventeen patients were treated by open reduction through the epiphyseal disc; eleven were immobilized in plaster for from ten to twelve weeks, and were followed for periods of two and one-half to seven years. Only two good results were obtained. In six patients internal fixation was used; the results two and one-half years later were excellent in two cases, fair in three, and poor in one.

The drilling operation was used in forty cases, so far with good results in thirty-five, although it is still too early for a complete end-result analysis.

Subtrochanteric osteotomy for deformity is advocated.—*F. E. Thornton, M.D., Iowa City, Iowa.*

Synovial Sarcomas in Joints, Bursae, and Tendon Sheaths. A Clinical and Pathological Study of Sixteen Cases. Dominic A. De Santo, Robert Tennant, and Paul D. Rosahn. *Surgery, Gynecology and Obstetrics*, LXXII, 951, 1941.

The authors report on a study of sixteen cases of synovial sarcoma. These usually originate in synovial tissue, and thus are found in joints, para-articular bursae, and tendon sheaths. These tumors usually fall into three types: (1) encapsulated, (2) circumscribed, (3) diffuse. From their own cases and some from the literature, the authors found the order of frequency of joint involvement to be: knee, elbow, forearm, thigh, shoulder, finger, and foot. The etiology is considered to be trauma and the influence of a chronic bursitis or synovitis. Symptoms are usually pain, tumor, joint dysfunction, and occasionally swelling. Roentgenographic examination gives positive evidence late in the disease; and symptoms are usually likewise late. Ten of the thirteen patients x-rayed showed a soft-part tumor near the joint. In two cases bone destruction was the only visible finding.

Treatment is quite radical, early amputation being of the greatest value. Excision only leads to early recurrence. The value of roentgen therapy has not as yet been established.

These tumors usually appear as undifferentiated fibroblastic tumors, generally indistinguishable from fibrosarcoma or spindle-cell sarcoma, unless synovial clefts or small areas of reticulo-endothelial evolution are located. In general, slow growth and late metastasis are the rule.—*F. E. Thornton, M.D., Iowa City, Iowa.*

Diagnosis of Sciatica and Low Back Pain Due to Herniation of Intervertebral Disks. G. E. Haggart. *Surgical Clinics of North America*, XXI, 889, 1941.

The author states that 3 per cent. of all patients who come to the Clinic for relief of low-back pain are found to have a protrusion of the intervertebral disc. Oxygen in the subarachnoid space is used exclusively at Lahey Clinic to demonstrate the defect in the roentgenogram. The history is characteristic and well known. He states that sensory changes are found almost exclusively in those patients with large disc protrusions, in whom there is muscle-wasting in the gluteal region as well as fibrillary twitchings of muscles either in this area or throughout the lower extremity on the involved side. Determination of the total protein content of the spinal fluid is important, and, if elevated, is evidence in favor of subarachnoid irritation. The author finds that, in those patients engaged in laborious work, and particularly in the individuals who exhibit an unstable lumbosacral articulation, fusion of this joint done at the same time as the laminectomy has given a better end result than has laminectomy alone.—*J. E. Fuchs, M.D., Iowa City, Iowa.*

COMPRESSION FRACTURES OF THE DORSOLUMBAR VERTEBRAE. John W. Gullikson and Edward R. Anderson. *Western Journal of Surgery, Obstetrics and Gynecology*, XLIX, 576, 1941.

The authors stress the importance of the "Soto-Hall" sign. This test is performed by acute flexion of the neck, and causes pain at the fracture site due to stretching of the ligamentous attachments of the vertebrae. By this test many fractures likely to be missed can be discovered.

In the treatment advocated, the patient is placed in bed and a sling is placed about him at the fracture site with a pulley arrangement and about forty to fifty pounds of overhead traction. This produces gradual hyperextension which the authors believe superior to rapid forceful methods, especially in patients with other injuries. The patient is allowed to rest in this apparatus for from four to ten days, and is then placed in a Rogers hammock frame in hyperextension. A body cast is then applied in this position, care being taken that a tight fit is secured about the pelvis. A window is cut in the abdomen to facilitate breathing. The patient is allowed up and about with the cast after two or three days. This is worn for at least two or three months, and is followed by a Taylor spinal brace for another two months, after which physiotherapy and graded exercises are started. The usual patient is able to discard his brace in from six to eight months, and is able to return to his usual work at that time.

Thirty-four cases of compression fracture were treated by this method. The average length of disability was eight and two-tenths months. There was one operation for compression symptoms of the cord to which the patient responded successfully. No development of Kümmell's disease was seen in this series. Thirty-two patients were able to return to their regular work; twelve had occasional backaches, though not severe enough to cause loss of time; and sixteen were symptom-free.—*F. Harold Downing, M.D., Fresno, California.*

COMPOUND FRACTURES. Carleton Mathewson, Jr. *Western Journal of Surgery, Obstetrics and Gynecology*, XLIX, 628, 1941.

The author reviews the principles gained from his experience in treating over 500 cases of compound fractures within the past ten years. He regards a compound fracture as an urgent emergency, and believes that, if infection is to be avoided, débridement must not be delayed, and every effort must be made to thoroughly cleanse the wound. Accurate immobilization is essential. Infected wounds, and wounds that cannot be closed without tension, should be left open and packed with vaseline gauze. Infrequent dressings are advised. Primary closure is justified when the local conditions warrant its use.

Prophylaxis against tetanus and gas infection was always given and, in addition, small doses of roentgen therapy were given locally to the wounds, through the cast, immediately and on the following two days. What effect this has had upon the development of gas infections, the author is not prepared to say.—*F. Harold Downing, M.D., Fresno, California.*

RHEUMATISMUS, ENDOKARDITIS UND TUBERKULOSE IM KINDESALTER (Rheumatic Fever, Endocarditis, and Tuberculosis in Childhood). E. Glanzmann. *Zeitschrift für Rheumaforschung*, IV, 169, 1941.

The author reports the occurrence of three examples of tuberculous infection, with joint swelling, pain, and endocarditis. The tuberculous infection was in the lungs or lymph nodes. The condition greatly resembled a rheumatic fever. In all of the cases the endocarditis subsided. There seemed to be less probability that two infections were present than that the entire symptomatology was due to tuberculosis. Arthritis in the sense of acute polyarthritis is very rarely a sequel to tuberculosis. Umber found only three cases of polyarthritis in 700 cases of tuberculosis, and Edström found eleven cases of polyarthritis in 694 cases of tuberculosis.—*John G. Kuhns, M.D., Boston, Massachusetts.*

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Archivos del Hospital Israelita. Revista de la Asociación de Médicos del Hospital Israelita (Buenos Aires, Argentina), IV, 1940–1941.

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Biological Surgery in bones-tuberculous patients. By Carlos Robertson Lavalle, Buenos Aires, Argentina, 1941.

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Bulletin of the Hospital for Joint Diseases (New York, N. Y.), II, No. 4, 1941; III, No. 1, 1942.

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